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Armstrong, Joseph E
Kalispell storm drain monitoring project, MF 6799(09)

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FINAL REPORT
KALISPELL STORM DRAIN MONITORING PROJECT
MF 6799(09)

BY:
Joseph E. Armstrong
Supervisor Geology Section
and
R. Scott Barnes
Civil Engineer III

MONTANA DEPARTMENT OF HIGHWAYS

MAY 31, 1984

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ACKNOWLEDGEMENTS

Many organizations have been consulted to assist us in developing a sound testing program, to provide historical data, and for technical advice as we began and progressed with the study. We want to thank the Environmental Protection Agency, the Montana Department of Health and Environmental Sciences, the Montana Department of Natural Resources, the Montana Bureau of Mines and Geology, the University of Montana, the Flathead County 208 staff, the U.S. Geological Survey, and the Federal Highway Administration for their assistance.

Dr. Jack Stanford and the University of Montana's Experimental Station at Yellow Bay and Ms. Rene Sol of the Montana Environmental Laboratory located in Kalispell need special recognition for jobs well done in the chemical and biological analysis work carried out for this project.

We would like to thank all those in the Missoula District who helped in the development of this report, especially Mr. Gary Kalberg for his efforts in collecting the data and assistance in preparing this report. A special thanks to Mr. Marc Spratt who worked with us and taught us while he prepared the Progress Report of 1982. Without his teaching we could not have completed this work. Finally the Federal Highway Administration for their financial assistance and technical guidance, particularly Mr. Bill Bellinger, of the Demonstration Projects Division.

INTRODUCTION

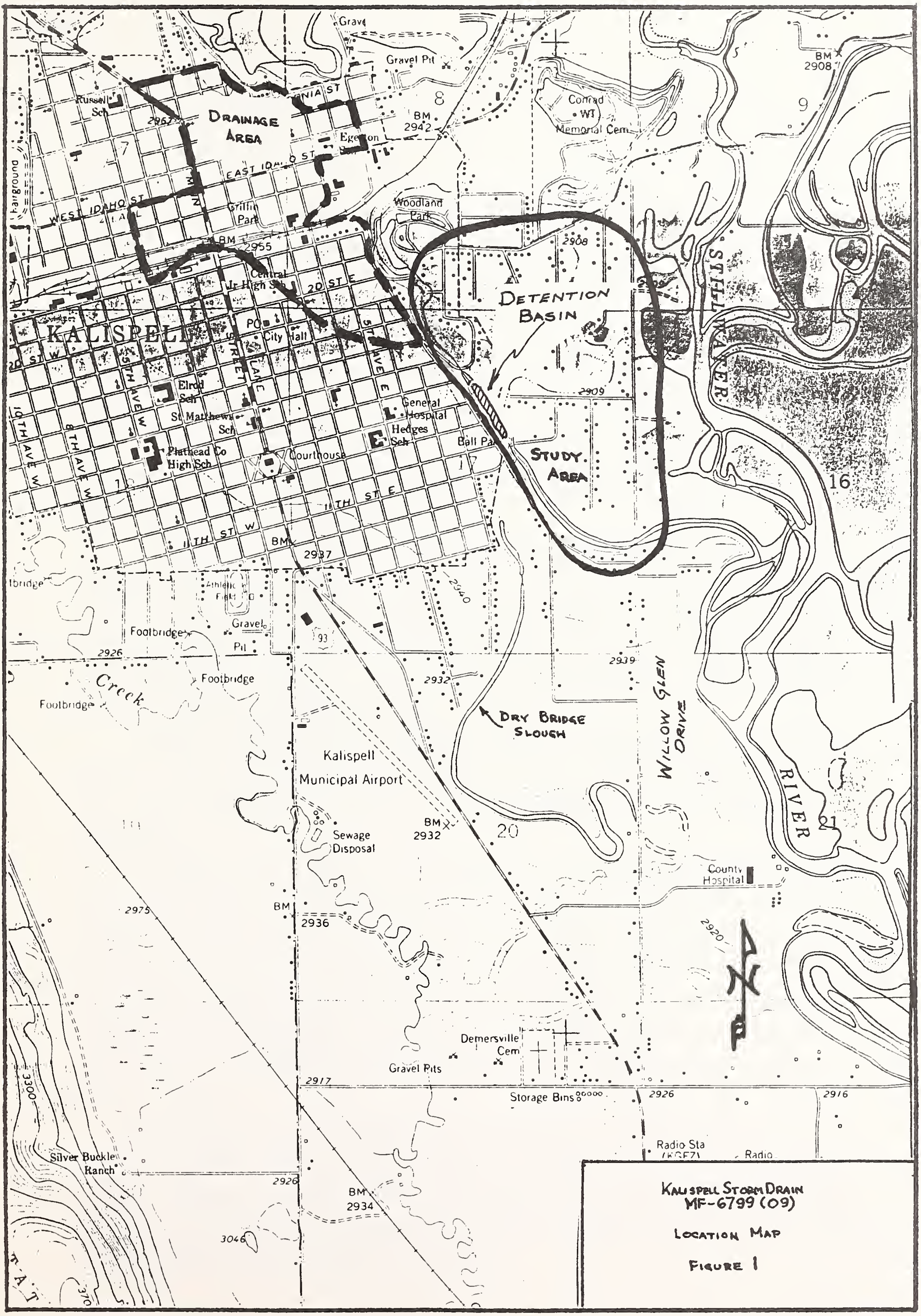
The Montana Department of Highways (MDOH), in cooperation with the City of Kalispell, and the Federal Highway Administration, (FHWA) constructed a storm drain system, including a detention basin, in 1980. A water monitoring project was initiated in response to complaints of persons living in the area, that the basin could adversely affect the ground and surface waters in the local area. The Department of Highways decided that the waters should be monitored to make sure that such was not the case, and so that if there were adverse affects the design could be modified in order to eliminate the problem.

The study area is located in parts of Sections 8, 9, 16 and 17, T28N, R21W (Figure 1). The area generally lies within the floodplain of the Flathead River below the confluence of the Flathead and Stillwater Rivers. Woodland Park, on the northwestern boundary of the study area, has a lagoon, filled by flows from an artesian well (300-600gpm) and storm water drainage north of Woodland Park. The area east of the detention basin, potentially impacted by seepage losses from the basin, is outside Kalispell city limits. Following is a narrative history of this project.

In Spring of 1980, Federal Aid Project MF 6799(7) was let and construction was initiated. This project was designed by a consultant and included, among other things, construction of 2.6 miles of storm drain and a detention basin. This new storm drain system replaced a storm drain system of approximately 203 acres which discharged about 500 feet upstream from the new detention pond. The old system had no detention facility for water treatment.

The area drained by this new storm drain system is approximately 251 acres. About 45% of this area is pervious and 55% is impervious. This drainage area is a portion of the northeast section of the city of Kalispell, see Figure 1. The city of Kalispell is situated on a bench about 50 feet in elevation higher than the river bottom area where the detention basin is located.

The detention basin area is in the flood plain of the Flathead-Stillwater River complex, see Figure 1. Groundwater elevation



Kalispell Storm Drain
MF-6799 (09)

Location Map

Figure 1

in the area is mainly dependant upon the Flathead-Stillwater River stages and is normally between five and fifteen feet below ground level. This area is outside Kalispell city limits and therefore has no common water or sewage systems. Consequently, most water is supplied by shallow (25 to 30 foot) wells. Sewage is taken care of with individual septic systems. Groundwater quality in this area is satisfactory most of the year and it becomes locally poor during high water periods as the groundwater comes nearer to the adsorption fields. Septic system installation is limited due to seasonal high water table elevations.

In Fall of 1980, the city of Kalispell and the Department of Highways received several complaints concerning the storm drain design from citizens living in the area surrounding the detention basin. By this time, most of the construction had been completed, but the storm drain was not yet in service.

On November 20, 1980, a meeting was held in Kalispell with representatives of the City of Kalispell, Flathead County, Department of Highways and Thomas Dean and Hoskins, the consultant who designed the project. Later that day a public meeting was held with the above representatives present. At this meeting, residents of the detention basin area voiced their concerns.

Several department meetings were held to determine the course of action. Water monitoring was found to require large expenditures and long term commitments, which would necessitate new projects or agreements.

On January 20, 1981, a meeting was held at the University of Montana Biological Station at Yellow Bay with D.O.H., City of Kalispell, Flathead County 208 Study and Biological Station personnel present. A monitoring program was discussed and designed. Many aspects of the program were discussed including such things as sampling site locations, sampling schedules and procedures, chemical and biological testing procedures and requirements, length and scope of the program, accuracy requirements and program costs.

Monitoring of the surface and groundwaters in the area around the detention basin, known as Days Acres, commenced in December of 1980 and ended in August of 1983. Monitored parameters include; surface water flows, water chemistry and bacterial concentrations, precipitation within the watershed and groundwater elevation.

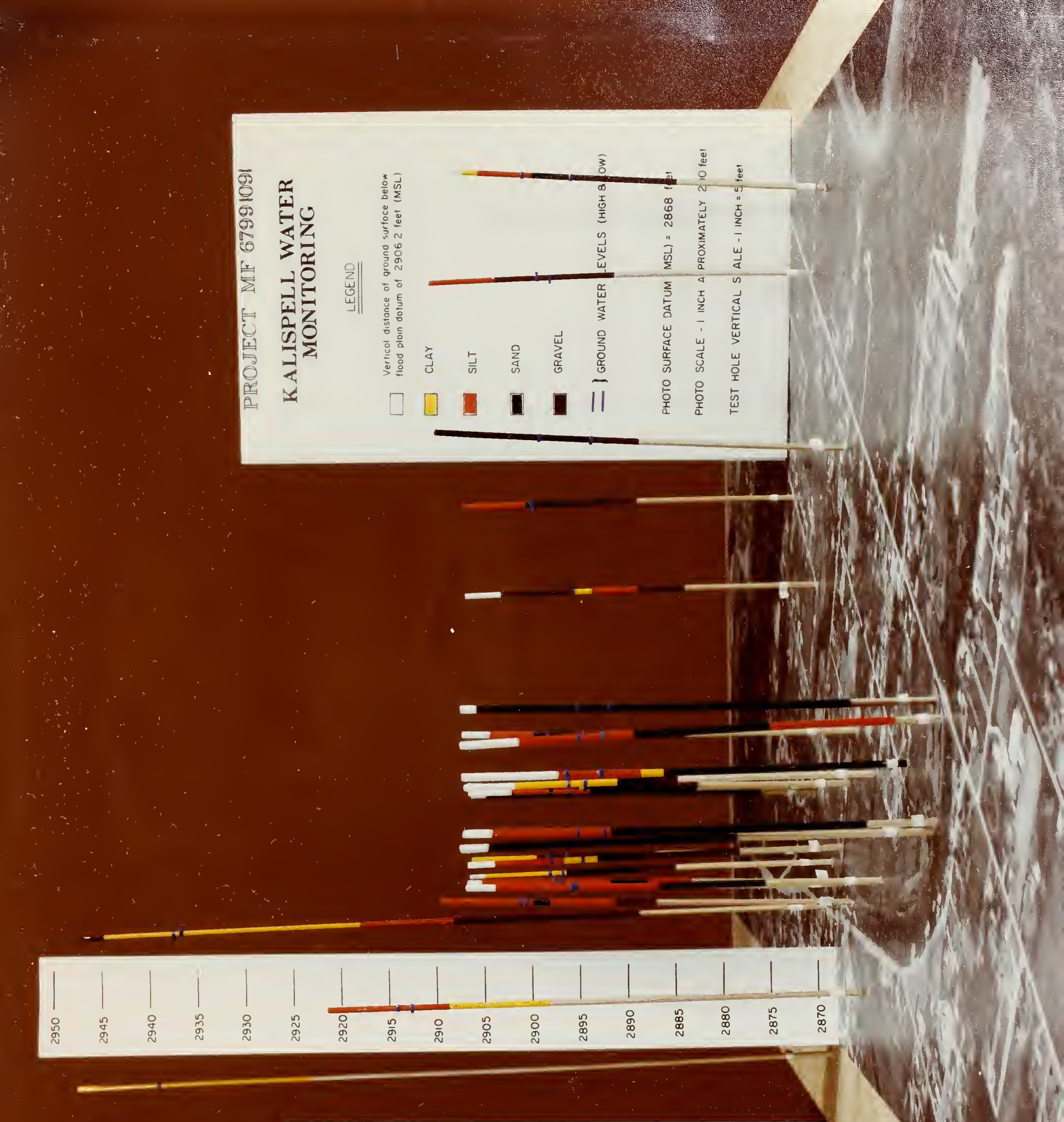
This report summarizes current information to conclude the Kalispell Storm Drain Monitoring Project, and is the final report for FHWA Demonstration Project No. 56-Montana.

The primary conclusion based on this work is that no adverse effect is caused by the Kalispell storm drain system.

SOILS

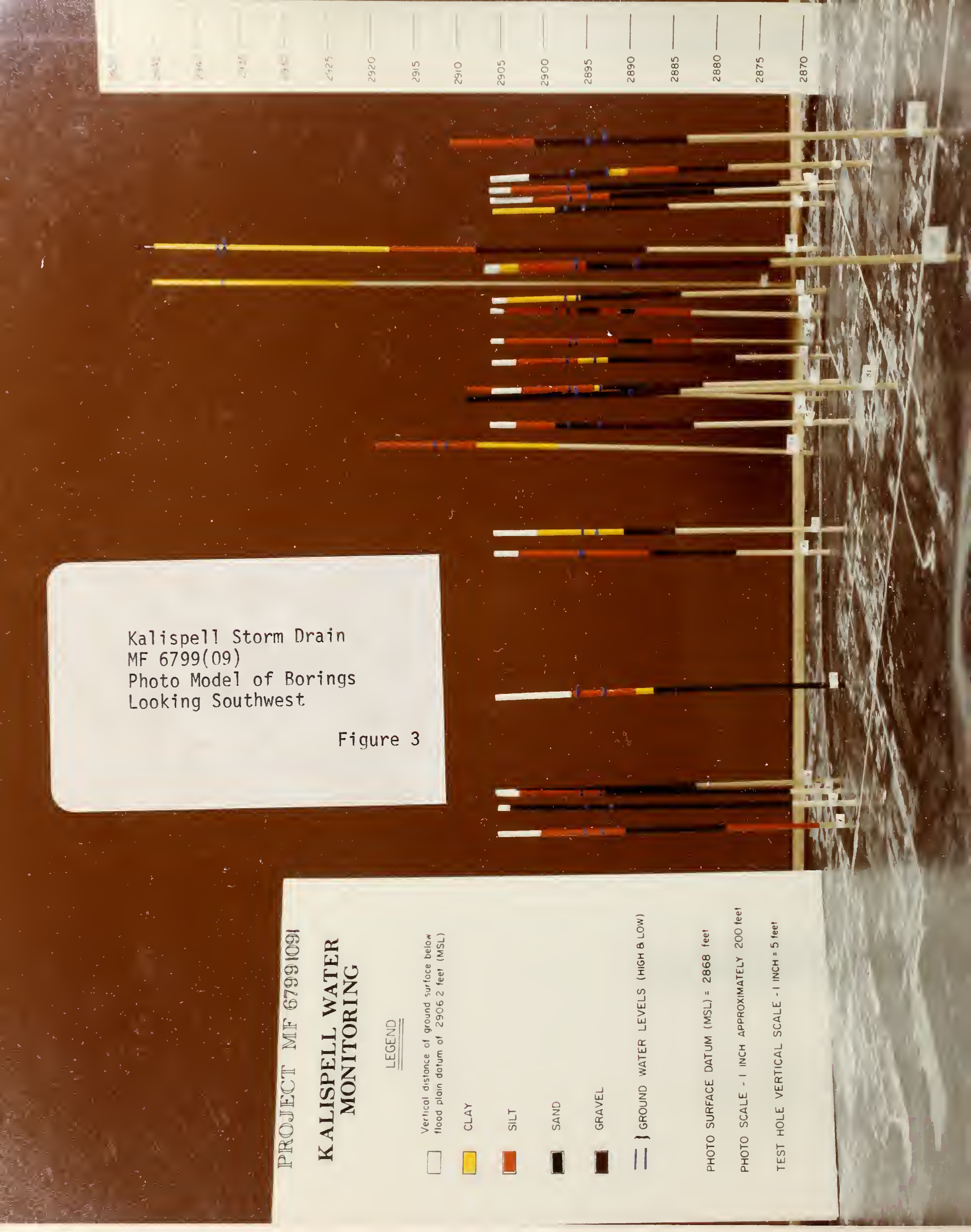
Soils mapping for the area (USDA, 1960), indicates normal floodplain soils with varying degrees of permeability but generally fine loamy soils. The drill logs from the test holes drilled for this project (see Appendix E) also show typical alluvial deposits with changing permeability characteristics. Figures 2 and 3 are photo models of the test drilling, which illustrate the material changes both laterally and vertically in the study area. Test holes in the area of the detention basin include silty clays, silts, fine sands, and gravels. Soil tests from the test holes indicate a general surface layer of sandy silt with facies of clayey soils near the detention basin.

The higher land surface to the west of the Flathead River floodplain is essentially silty clay soils of glaciolacustrine origin. Typical "varved" depositional features were noted during the construction through these soils.


PROJECT MF 6799(09)
KALISPELL WATER MONITORING
LEGEND
Vertical distance of ground surface below flood plain datum of 2906.2 feet (MSL)
CLAY
SILT
SAND
GRAVEL
GROUND WATER LEVELS (HIGH & LOW)
PHOTO SURFACE DATUM (MSL) = 2868 feet
PHOTO SCALE - 1 INCH APPROXIMATELY 200 feet
TEST HOLE VERTICAL SCALE - 1 INCH = 5 feet
2950
2945
2940
2935
2930
2925
2920
2915
2910
2905
2900
2895
2890
2885
2880
2875
2870

Kalispell Storm Drain
MF 6799(09)
Photo Model of Borings
Looking Northwest

Figure 2


PROJECT MF 6799(09)
KALISPELL WATER MONITORING
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2895
2890
2885
2880
2875
2870

Kalispell Storm Drain
MF 6799(09)
Photo Model of Borings
Looking Southwest

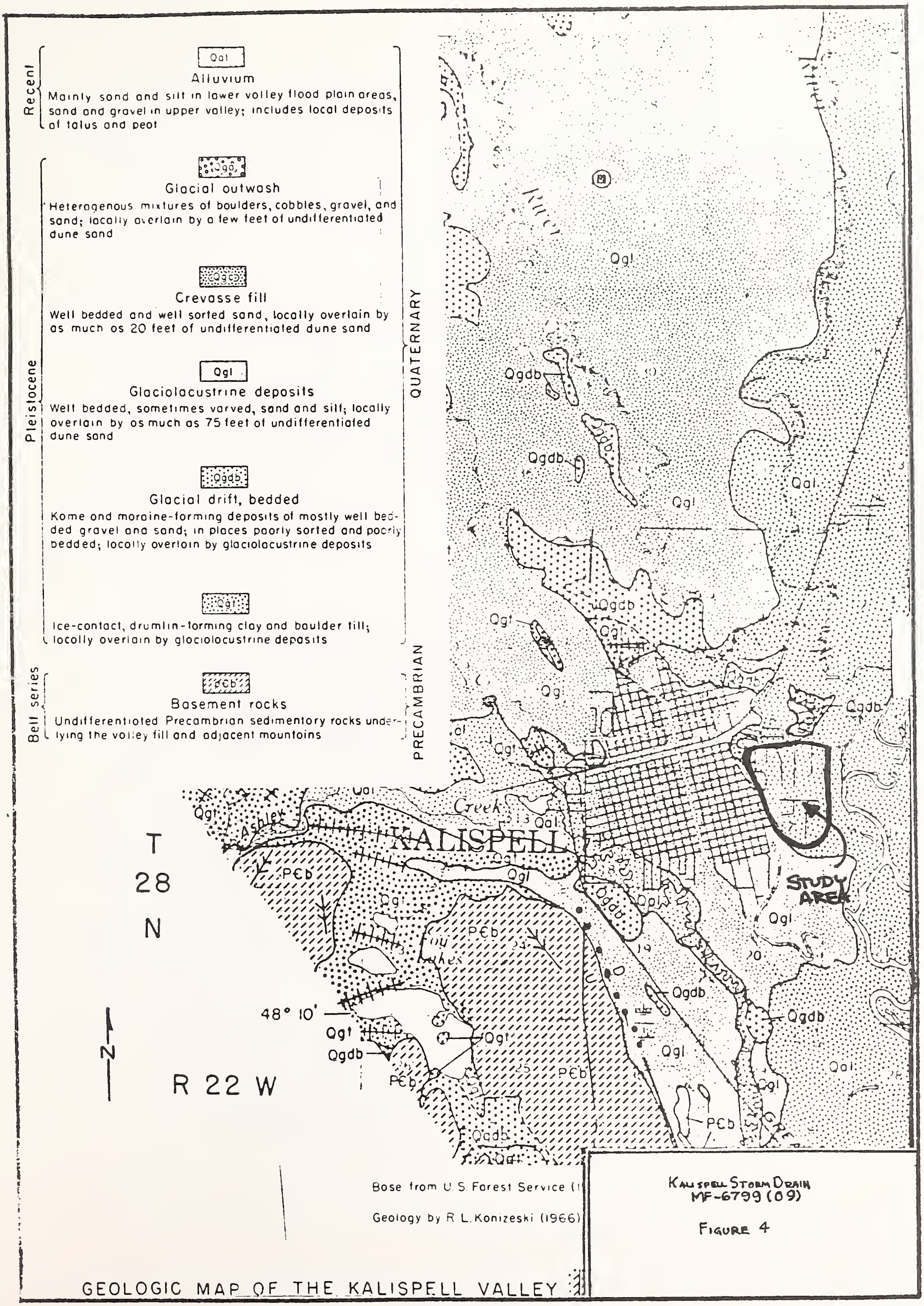
Figure 3

GEOLOGY

The general geology of the study area was mapped by Konizeski et al. (1968), Figure 4 is a portion of Konizeski's mapping. The geology in the study area is composed of Quaternary aged deposits with two major divisions. The older unconsolidated glaciolacustrine deposits are of Pleistocene age, while the alluvial deposits in the Flathead-Stillwater floodplain are of Holocene geologic age.

The glaciolacustrine deposits were observed in cross section along the trench excavation for the storm drain. Typical varved sands and clayey glacial silts, thin bedded to "varved" bedding with seepage along the sandy bedding planes was observed. These deposits underlie the City of Kalispell and form the bench feature that is the western boundary of the study area and the Flathead-Stillwater floodplain. The geologic depositional characteristics of these deposits control the groundwater conditions by limiting the permeability and effective aquifer(s) thicknesses. Permeability is very low vertically due to the varved nature, and only slightly higher horizontally because of the thin bedding and fine grain sizes. The hydrologic effect of these conditions should allow for very low flow rates through these materials. Observed spring activity along the bench supports the existence of this aquifer. This information is in agreement with the recovery test performed at test hole no. 23 and we have concluded that the hydraulic properties shown in Table 1 best describe this aquifer.

The alluvial deposits that are found in the Flathead-Stillwater floodplain are composed of unconsolidated silts, sands and gravels. The test holes shown in Figures 2 and 3 illustrate the near surface depositional characteristics of these alluvial soils. Aquifer flow is hydraulically connected and unconfined groundwater conditions exist. The lower portions of the alluvium tested, below 10 feet, indicate higher transmissivity than that of the surface silty soils found generally throughout the floodplain surface. A deep artesian aquifer underlies these deposits. Appendix E contains the drill logs for wells used in this study.


Recent
Qal
Alluvium
Mainly sand and silt in lower valley flood plain areas, sand and gravel in upper valley; includes local deposits of talus and peat
Pleistocene
Qgo
Glacial outwash
Heterogenous mixtures of boulders, cobbles, gravel, and sand; locally overlain by a few feet of undifferentiated dune sand
Qgc
Crevasse fill
Well bedded and well sorted sand, locally overlain by as much as 20 feet of undifferentiated dune sand
Qgl
Glaciolacustrine deposits
Well bedded, sometimes varved, sand and silt; locally overlain by as much as 75 feet of undifferentiated dune sand
Qgdb
Glacial drift, bedded
Kame and moraine-forming deposits of mostly well bedded gravel and sand; in places poorly sorted and poorly bedded; locally overlain by glaciolacustrine deposits
Qgt
Ice-contact, drumlin-forming clay and boulder till; locally overlain by glaciolacustrine deposits
QUATERNARY
Belt series
P€b
Basement rocks
Undifferentiated Precambrian sedimentary rocks underlying the valley fill and adjacent mountains
PRECAMBRIAN
River
Qgl
Qgdb
Qal
Qgt
Ashley
Creek
KALISPELL
P€b
STUDY AREA
48° 10'
T 28 N
N
R 22 W

Base from U.S. Forest Service (1

Geology by R.L. Konizeski (1966)

GEOLOGIC MAP OF THE KALISPELL VALLEY

Kalispell Storm Drain
MF-6799 (09)

Figure 4

Secondary erosional features can be found throughout the study area. Two such features are the Dry Bridge Slough deposit and the abandoned floodplain channel deposits.

The Dry Bridge Slough deposit is composed of fine silty sands that were deposited in a now abandoned channel, superimposed upon the glaciolacustrine deposits of the Kalispell Bench. Groundwater from the impounded Dry Bridge Slough drains through these soils into the study area floodplain near the detention basin. The chemical studies verify this groundwater movement.

Abandoned floodplain channels and their channel deposits are found throughout the floodplain. An occasional anomalous chemical change may be possible due to these deposits and their ability to control surface and groundwater flows. Some of these deposits can be seen in the test holes in Figures 2 and 3.

HYDROLOGY

The general geology and aquifers described by Konizeski are basically confirmed by our investigation. The analysis of well logs, test holes and the soil samples indicate that the shallow flood plain aquifer is typically alluvial deposits composed of interbedded sandy silts, silty sands and silty clays, overlying sands and sandy gravels.

These deposits are hydraulically connected to form the upper portion of the floodplain aquifer. It is this aquifer that receives any impact from the detention basin as well as surrounding surface recharges.

Potentiometric mapping (see Appendices B and C) indicates many sources contribute recharge to the shallow portion of the floodplain aquifer. The identified recharge sources are:

1) Stillwater River
2) Flathead River
3) Woodland Creek & Park Pond
4) Dry Bridge Slough

5) Perched Aquifers:
   a) Kalispell Bench Aquifer
   b) Dry Bridge Slough Aquifer
6) Kalispell Storm Drain
7) Vertical Discharge from Deeper Aquifers
8) Precipitation
9) Septic Tanks
10) Lawn Watering.

Several small anomalous configurations in the potentiometric mapping suggest additional recharge sources within the study area which may be caused by other recharge conditions, various hydrologic events, abandoned stream channels and sloughs found throughout the floodplain surface.

Thirty-eight wells were drilled in the study area. Generally, the bottom 10' of casing in the wells is perforated and gravel packed. Well construction details and well logs are in Appendix E.

Water levels were monitored on a regular basis. Elevations are measured to the nearest one hundredth of a foot. Well head elevations have been measured. Water level recorders were installed at 10 locations to provide continuous records of water level fluctuations. This data is shown on plates 1 to 4.

The detention basin was monitored during the study to determine flow rates, infiltration into the floodplain soils and siltation rates. Plate 5 is a continuous plot of the water level within the basin from 9/1/81 to 7/1/82. Infiltration rates vary with hydraulic head elevations. The water levels recorded indicate that only during significant precipitation events will water rise in the basin and therefore the infiltration of storm drain water occurs for only short durations, an expected condition. The water levels suggest an adequate design of detention capabilities for the basin. Siltation studies indicate an average sediment deposition rate of 65 cubic yards per year.

Several piezometric maps have been prepared to illustrate various conditions of the hydrologic cycle during the study. Appendix B is a compilation of these maps.

Aquifer hydraulic characteristics were determined two ways.

1.)	Recovery tests	Determine the aquifer hydraulic properties (transmissivity, and hydraulic conductivity).
2.)	Flow estimate	Based upon specific capacity from drill logs and hydraulic gradient from potentiometric mapping.

Ground Water

The groundwater aquifers that have been recognized in this study are the Flathead-Stillwater floodplain, the Kalispell bench and the Dry Bridge Slough aquifer.

Flathead-Stillwater Floodplain Aquifer

The test drilling models shown in Figures 2 and 3 indicate a complex aquifer due to the varying depositional conditions typical of floodplain environments. Several of the test holes were drilled into "channel" deposits of higher permeable materials than the normal sandy silty soils.

Groundwater flow patterns are generally described by the potentiometric maps in Appendix B and indicate, by the flat gradient, high transmissivity.

Table 1 contains data developed from several recovery tests conducted and estimates of aquifer properties to provide groundwater flow values. Generally it can be stated that the transmissivity values imply slow groundwater flow in the upper portion of this aquifer. Pump tests proved to be inadequate due to the shallow well depths and well construction. Originally these wells were intended to be water sampling sites and groundwater level points.

Kalispell Bench Aquifer

This is a perched aquifer under the City of Kalispell through which water flows toward the study area from west to east and recharges the Flathead-Stillwater floodplain. The soils are varved glaciolacustrine

deposits. These soils were observed during the construction of the storm drain along Sylvan Drive and Woodland Avenue. Our test hole no. 14 encountered glacial till at about 10 feet above the Flathead-Stillwater floodplain. Based on the spring activity along the bottom of the bench, this contact acts as the base of the Kalispell Bench aquifer and allows a fairly accurate determination of the aquifer thickness.

Other factors that influence flow from this aquifer are the interception of flow by the storm drain and other aquifers superimposed over these deposits such as the channel deposit of sandy soils of the Dry Bridge Slough aquifer.

Dry Bridge Slough Aquifer

This aquifer is composed of sandy materials that were deposited from a poorly developed abandoned drainage on the surface of the glaciolacustrine deposits of the Kalispell Bench. This aquifer was discovered during this study (Spratt-1982) due to water chemistry that does not compare with the Kalispell Bench aquifer chemistry or the Storm Drain Basin water chemistry. Spring seepage indicates a relatively small flow from this source, estimates are shown on Table 1. Drilling information and monitoring during 1983 confirmed this aquifer.

Summary

Groundwater recharge sources to the Flathead-Stillwater floodplain aquifer(s) have been identified. It is obvious that the surface waters from the Flathead River and Stillwater River are the dominant factor governing the groundwater flows throughout the study area. The geological conditions and chemical characteristics of the floodplain aquifer further support this conclusion.

The other recharge sources studied (Woodland Creek, Kalispell Bench aquifer, Dry Bridge Slough aquifer, and the Detention Basin) are much smaller in flow rates and therefore their affects upon the upper portion of the Flathead-Stillwater Floodplain Aquifer are local in nature and are reflected in the data as anomalous conditions in the potentiometric mapping and chemistry data.

AQUIFER RECOVERY TESTS & FLOW ESTIMATES

Aquifer & Well No.	Test Date	Pump Rate (gpm)	Maximum Draw Down (ft.)	Pumping Duration (hrs.)	Type of Test	Transmissivity (T)	Perm. Coef. (K)	Aquifer Flow Rate (Q)	Comment
Kalispell Bench - No. 23	8/16/82	1 to 2	8.0	0.25	Recovery	10 ft^2/day	.5882	1365 ft^3/day	
Kalispell Bench - No. 23	8/16/82	1 to 2	8.0	0.25	Recovery	22 ft^2/day	.5882	512 ft^3/day	Q - revised (from Spratt - 1982) to reflect accurate cross-sectional area of aquifer
Floodplain* @ No. 3	4/6/83	1	5	4	Recovery	40 ft^2/day	2.4		Gradient = 0.0011 - Spratt - 1982
Floodplain* @ No. 5	8/10/82	0.9	8	0.5	Recovery	32 ft^2/day	1.16	530 ft^3/day	Composite estimate
Floodplain* @ No. 6	4/8/83	5.0	11	4.5	Recovery	50 ft^2/day	3.69		
Floodplain* @ No. 9b	3/25/83	1	7	4.5	Recovery	100 ft^2/day	8.7		
Floodplain* @ No. 13b	3/23/83	13	2.5	5	Recovery	717 ft^2/day	59.2		Results questionable due to poor time/recovery recording
Dry Bridge Slough	ESTIMATE No Pump Test					15 ft^2/day	0.50	33 ft^3/day	K - (estimated - Todd)
Flathead - Stillwater	ESTIMATE No Pump Test					550 ft^2/day	3.67	2420 ft^3/day	Spratt - 1982 ('T' may be low) - based on 150-foot thickness
Flathead - Stillwater	ESTIMATE No Pump Test					55 ft^2/day	3.99	530 ft^3/day	Average T & K - from pump tests above for top 30 feet of floodplain
Flathead - Stillwater	ESTIMATE					1200 ft^2/day	10.0	5280 ft^3/day	K (from Todd) for 30 feet to 150 feet of floodplain aquifer
								5810 ft^3/day	Total flow for top 150 feet of aquifer

*The low values shown are intended to represent values in the upper portion of the Floodplain aquifer.

TABLE 1
RECOVERY TEST DATA AND FLOW ESTIMATE
FOR THE KALISPELL STORM DRAIN PROJECT

JA/SK/209aa

Spratt (1982) describes the Kalispell Bench aquifer(s) with the recovery test at test hole No. 23 and a leakage test from these deposits by measuring flow in Woodland Creek between the outlet of the detention basin and Willow Glen Drive. His conclusion is that the transmissivity based on the leakage test was most accurate and he used this volume for further comparisons. We disagree for the following reasons:

1. The flow variations measured in the leakage test are within acceptable USGS error limits; therefore the yield of 0.09ft^3/sec. indicated at best a near balanced condition, suggesting a low flow rate in the Kalispell Bench aquifer(s).
2. The leakage tests, though more direct in measurements than the recovery test, has several problems with the measurements due to creek flow and channel configurations.
3. The aquifer description used by Spratt is accurate for only a small segment of the perched aquifers. We have divided the aquifer to delineate leakage from the Dry Bridge Slough sandy deposits and the varved deposits of the Kalispell Bench which are geologically separate perched aquifers. Realizing the glaciolacustrine deposition, which is by far the largest cross sectional area for the perched aquifers, flow rates should be anticipated to be low. These materials support the hydraulic values estimated from the recovery test at test hole No. 23.

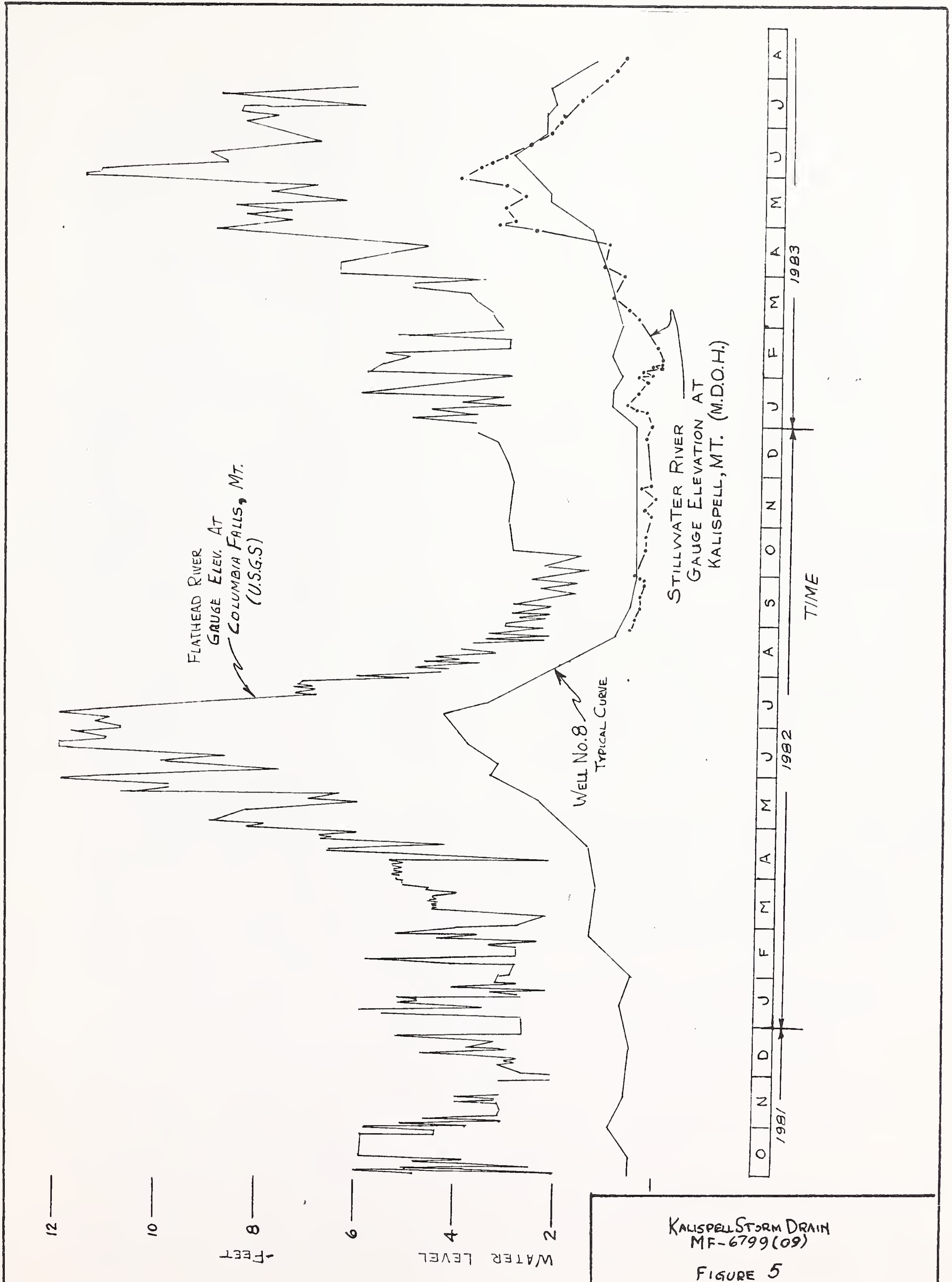
We, therefore, conclude that the leakage from the perched aquifers found within the Kalispell Bench is low. The leakage from the Dry Bridge Slough is low but due to the lateral and basal confinment caused by the geologic depositional characteristics this groundwater can act as a point source load similar to the detention basin.

SURFACE WATER

River elevations were recorded on the Stillwater River above the study area by a water level recorder. Flathead River elevations were monitored with a staff gage below the study area. Figure 5 shows a good response relationship between the river level fluctuations and the groundwater levels in the study area. Precipitation records were obtained from the Department of Commerce National Weather Service for the station at Glacier International Airport. Records of precipitation within the watershed were recorded on instrumentation located at the MDOH office in Kalispell. Precipitation was monitored throughout the project. Plates 1 to 4 illustrate precipitation and the groundwater cycle during the study period. Figure 6 also illustrates the effect of precipitation.

Sources of recharge to the study area groundwater system appear to be the Dry Bridge Slough, detention basin, Woodland Creek, Flathead-Stillwater River and precipitation. Irrigation is not practiced on a commercial scale in the area though some recharge occurs from lawn watering, car washing, septic tanks and other similar activities by area residents. Underlying aquifers may produce vertical recharge. These sources have not been quantified. Flows of the sources identified below have been generally quantified at peak flow. These values are only useful as order-of-magnitude flow estimates. Flows in these streams respond to "normal" precipitation and snowmelt events.

Stillwater River	-	1,600 cfs
Flathead River	-	40,000 cfs
Woodland Creek	-	1 cfs
Detention Basin (inlet)	-	9 cfs



Kalispell Storm Drain
MF-6799(09)

Figure 5

Hydrologic Cycle

WATER QUALITY

To determine the effect of the storm drain system it was decided that a rather extensive effort be made to monitor and test the water quality in the study area. Both surface and ground water were monitored during the study. Storm events were monitored in the basin by utilizing an ISCO automatic sampler to permit sampling of storm water inflow to the detention basin.

Chemical and physical parameters were measured by the University of Montana, Yellow Bay Biological Station. The final monthly sampling parameters were; pH, specific conductance, alkalinity, orthophosphorus, nitrate-nitrogen, sulfate-sulfur, chloride, calcium, magnesium, sodium, potassium, turbidity, dissolved organic carbon, grease and oil, and total suspended solids (surface only). Storm event samples were analyzed for pH, specific conductance, nitrate-nitrogen, sulfate-sulfur, alkalinity, chloride, calcium, magnesium, sodium, potassium, and iron. The list of parameters measured was modified slightly several times during the study, due to unforseen problems.

Metals (cadmium, chromium, lead and iron) were determined by Kenwill, Inc. on contract with the Federal Highway Administration.

Bacteriological samples were prepared by the Montana Environmental Laboratory in Kalispell within 8 hours of sampling. Well samples were analyzed for total coliform bacteria and surface samples were analyzed for fecal coliform bacteria.

Temperature and specific conductance were measured in the field when the samples were acquired. Standard acceptable procedures for the sampling, and care of the sample were followed throughout the study. Chain of custody records and procedures were satisfactorily maintained and followed during sample acquisition and transport.

The Chemistry section of this report discusses in detail the analysis of the sampling. Soil chemistry historically shows large amounts of calcium which can be expected from the weathering of the Siyeh Formation, a dolomitic limestone, common in the drainage. As the sodium rich waters move through the aquifer, sodium replaces the calcium adsorbed on the fine materials (Spratt-1982).

Water quality is often measured with the Sodium Adsorption Ratio (SAR). SAR is used as a measure of water quality for irrigation purposes. It is a measure of the adsorption of sodium by soil to which the water has been added.

Any value less than 10 is considered to be excellent (U.S. Department of Agriculture). As shown on Table 2 (below) all SAR values are less than 10. The Dry Bridge Slough waters tend to have the highest values (lowest quality) of those shown.

Another measure of water quality is the Water Classification (U.S. Department of Agriculture). This system is also used predominately to measure the quality of water for irrigation purposes. A nomograph of SAR versus specific conductance is used to arrive at the classification. A C1-S1 water would be best, while a C4-S4 water would be unacceptable for most irrigation purposes.

Of all the waters identified for this study, only the Dry Bridge Slough waters have characteristics which limit their use for irrigation purposes.

Table 2 above shows the waters of the study area arranged in order of best to worst for irrigation purposes.

SAR/WATER CLASS.	LOW WATER Nov. 18, 1981	RISING LIMB Apr. 20, 1982	HIGH WATER July 13, 1982	FALLING LIMB July 13, 1983
Flathead River	--	0.1/C1-S1	--	2.8/C1-S1
Detention Basin	0.5/C1-S1	3.2/C3-S1	0.5/C1-S1	1.7/C2-S1
Kalispell City #23 (10-19-82)	1.7/C2-S1	1.6/C2-S1	1.2/C2-S1	1.5/C2-S1
Woodland Creek	0.3/C2-S1	0.3/C2-S1	1.3/C2-S1	4.2/C2-S1
Floodplain Well 5	0.9/C2-S1	0.8/C3-S1	1.0/C2-S1	3.3/C3-S1
Dry Bridge Slough	6.9/C3-S2	5.0/C3-S2	--	5.8/C3-S2

TABLE 2. Sodium Adsorption Ratios and Water Classifications of Waters in the Storm Drain Study Area.

CHEMISTRY

The chemical and biological analyses from April 15, 1981 to July 13, 1983 are on file in SPSS format on the department's computer in Helena, Montana. Selected graphic plots of the data are included for specific monitoring sites in Appendix D.

The sampling is adequate to identify the quality of the water sources within the study area. Figure 6 is a key for the various sampling analyses and their relationship with precipitation and groundwater conditions.

The general chemical values that compare the ground water quality to drinking water standards are shown in Table 3. The drinking water standards have been established by the Montana Department of Health and Environmental Sciences and the U.S. Environmental Protection Agency to indicate excessive concentrations. Reviewing the data shown in Table 3, only iron and bacteria have exceeded the recommended drinking water standards. The concentration of iron is common in this area and not due to the storm drain system. Bacteria data indicates expected long term trends throughout the entire floodplain, low in the winter and high in the summer, and is therefore not due to the storm drain system.

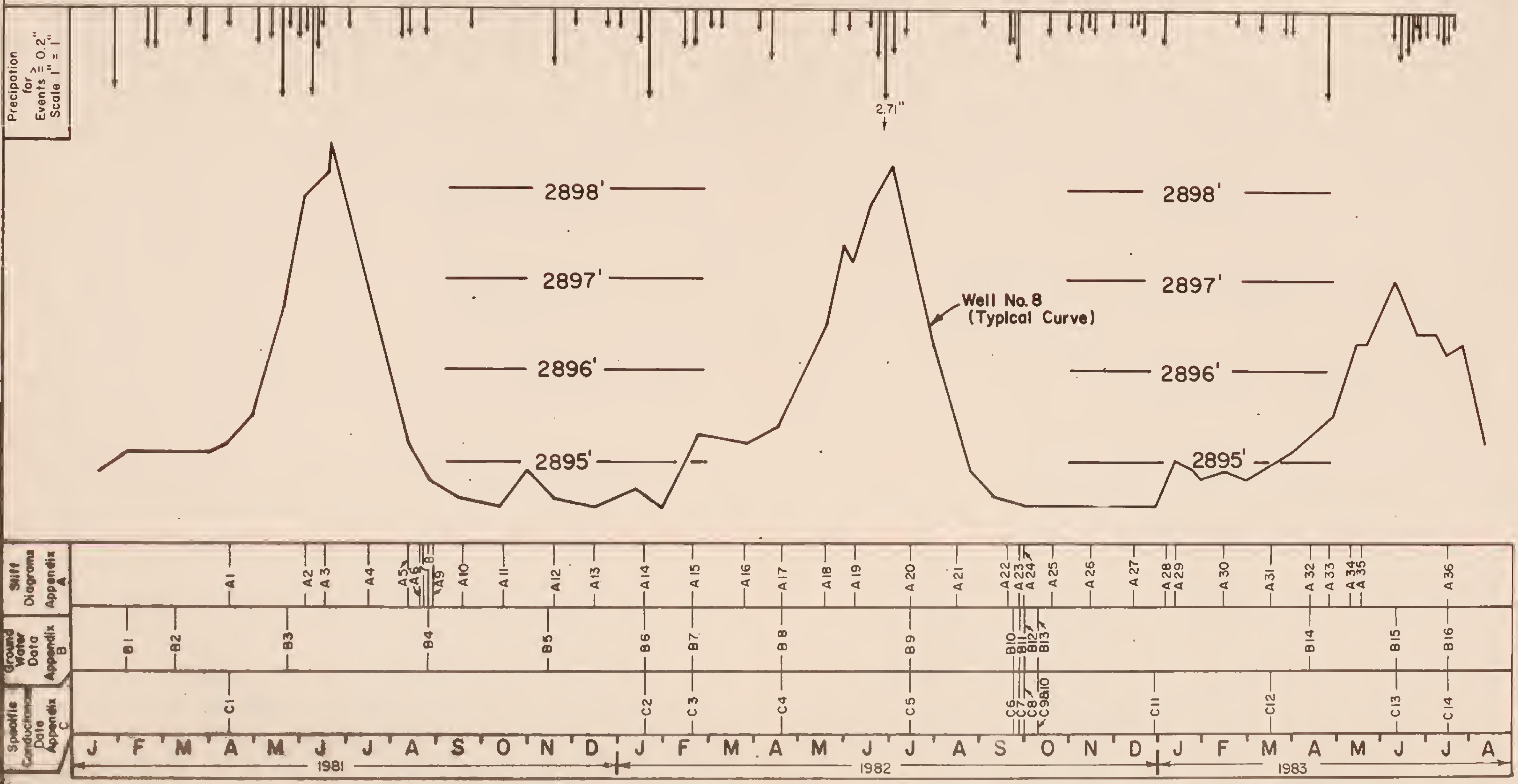
Chemical parameters show trends of increase in concentration during low ground water conditions and a decrease in concentration during high ground water conditions with anomolies that may correspond to melt and/or rain events. The wells adjacent to the basin are not clearly associated to the chemistry in the basin.

Based on the chemistry data and potentiometric mapping, Woodland Creek is not a complete hydrologic barrier. This observation can be seen in the influences on the Floodplain aquifer from the detention basin and the dry Bridge Slough Aquifer.

Stiff diagrams have been plotted of the chemistry data throughout the study period and selected dates are included in Appendix A. These diagrams offer an excellent review of the various chemistries of different water systems and general trends of the chemistry of the waters. Graphic plots of the data are in Appendix D.

The following brief summaries of recognized water systems are:

KALISPELL STORM DRAIN
MF-6799(09)



HYDROLOGIC & MONITORING DATA FIGURE 6

TABLE 3 - Comparison of Groundwater Quality To Drinking Water Standards

PARAMETER	RECOMMENDED LIMIT (mg/l)	NUMBER OF VIOLATIONS	LOCATION OF VIOLATION
NO_3-N	10	0	--
SO_4	250	0	--
Cl	250	0	--
Na	250	0	--
Fe*	0.30	1	Dry Br. Slough
		1	2W
		1	3W
		8	5W
		5	9W
		1	13W
		1	18W
		1	20W
		1	23W
Total Coliform	1	Many	Most

*NOTE: All metals samples obtained on or before January 20, 1982 were improperly preserved. The reported values are erroneous and are not used.

1. Flathead - Stillwater Floodplain Aquifer -- The shallow ground water supply within the floodplain of the study area is composed of a relatively stable chemical composition. The stiff diagrams for the wells in the floodplain aquifer such as wells 5 and 18 indicate constant chemical characteristics throughout the hydrologic cycle. The water quality of deeper ground water such as the artesian aquifer supplying Woodland Park in the floodplain were not studied due to the vertical separation of these waters.
2. Kalispell Bench Aquifer -- This water was identified in the preliminary report as the "perched aquifer" and is the aquifer in the glaciolacustrine deposits which underly the city of Kalispell, and recharges the Flathead - Stillwater groundwater supply along the western border of the study area. A constant chemical composition as shown in the stiff diagrams of well 23 exists throughout the hydrologic cycle. The chemistry of this water differs slightly from the Flathead - Stillwater floodplain aquifer.
3. Dry Bridge Slough Aquifers -- The perched groundwater within this drainage has much higher concentrations of sodium, calcium, magnesium, chloride, carbonate and sulfate ions than any of the waters that were observed during this study. The stiff diagram of July 12, 1983 (Appendix A-36) for wells 34, 35, 36 and 37 best describes this chemistry. This groundwater supply is recharged from the Dry Bridge Slough, a permanent impoundment within a small drainage on the Kalispell Bench. These waters then recharge the Flathead - Stillwater floodplain in the area of the detention basin.

   The chemical characteristics of the surface water in the Dry Bridge Slough show direct correlation to this aquifer.
4. Kalispell Storm Drain -- The water quality of the Kalispell storm drain system has been monitored during the study with an automatic sampling device during runoff events and also in field measurements at sample site 7s (in the basin itself).

   These waters vary considerably from low concentrations during non-runoff periods to very high concentrations during peak runoff.

No clear relationship can be made between the chemical composition of the storm drain waters and the groundwater in nearby wells (9, 13 and 20).

5. Dry Bridge Slough -- The surface samples in the Dry Bridge Slough contain the highest amounts of dissolved solids of all the sampled waters. There is a direct correlation between these waters and the groundwater downslope from the slough, identified as the "Dry Bridge Slough Aquifer".

   The ground water from the Kalispell Bench, the Dry Bridge Slough and the Kalispell Storm Drain apparently mix in the vicinity of the detention basin which causes a complex relationship with regard to the quality of the water in surrounding wells (9, 13 and 20). The groundwater quality differs in this area from the basic quality of the Flathead - Stillwater aquifer in that higher concentrations of sodium and sulfate ions are present.

   The higher concentrations observed in these wells have existed throughout the study period and no trend of increase with time has been seen. This observation is interpreted to be the norm for the groundwater chemistry in the vicinity of the detention basin. The chemistry quality of these wells is satisfactory from the aspect of existing drinking water standards.

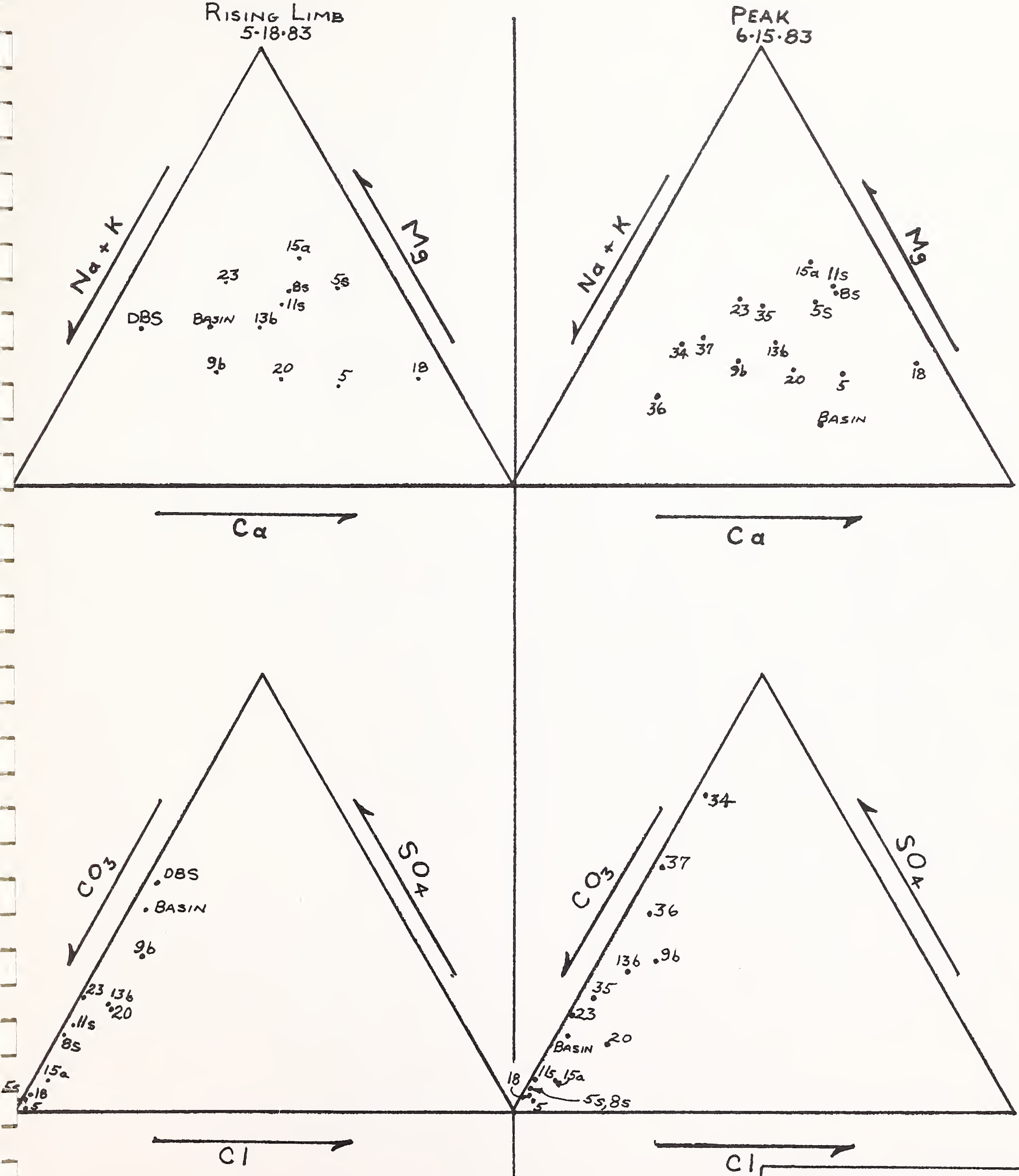
Analysis of the specific conductance data is based on the potentiometric mapping included in Appendix "C". Figure 6 illustrates the relationship between sample time and groundwater cycle. Generally the specific conductance decreases away from the Kalispell Bench, toward the Flathead River. The detention basin outlet and the Dry Bridge Slough Aquifer outflow are located in the same vicinity. An anomolous high in the potentiometric mapping exists in this area. The specific conductivity of the basin waters does not correlate with this anomoly. The groundwater from the Dry Bridge Slough correlates very well.

Trilinear diagrams, Figures 7 and 8, representing the low, rising, peak and falling portions of the hydrologic cycle indicate the following:

a) The groundwater ions (Na+K, Mg, Ca, SO4, CO3 and Cl) are relatively stable throughout the complete cycles; however the basin's ions

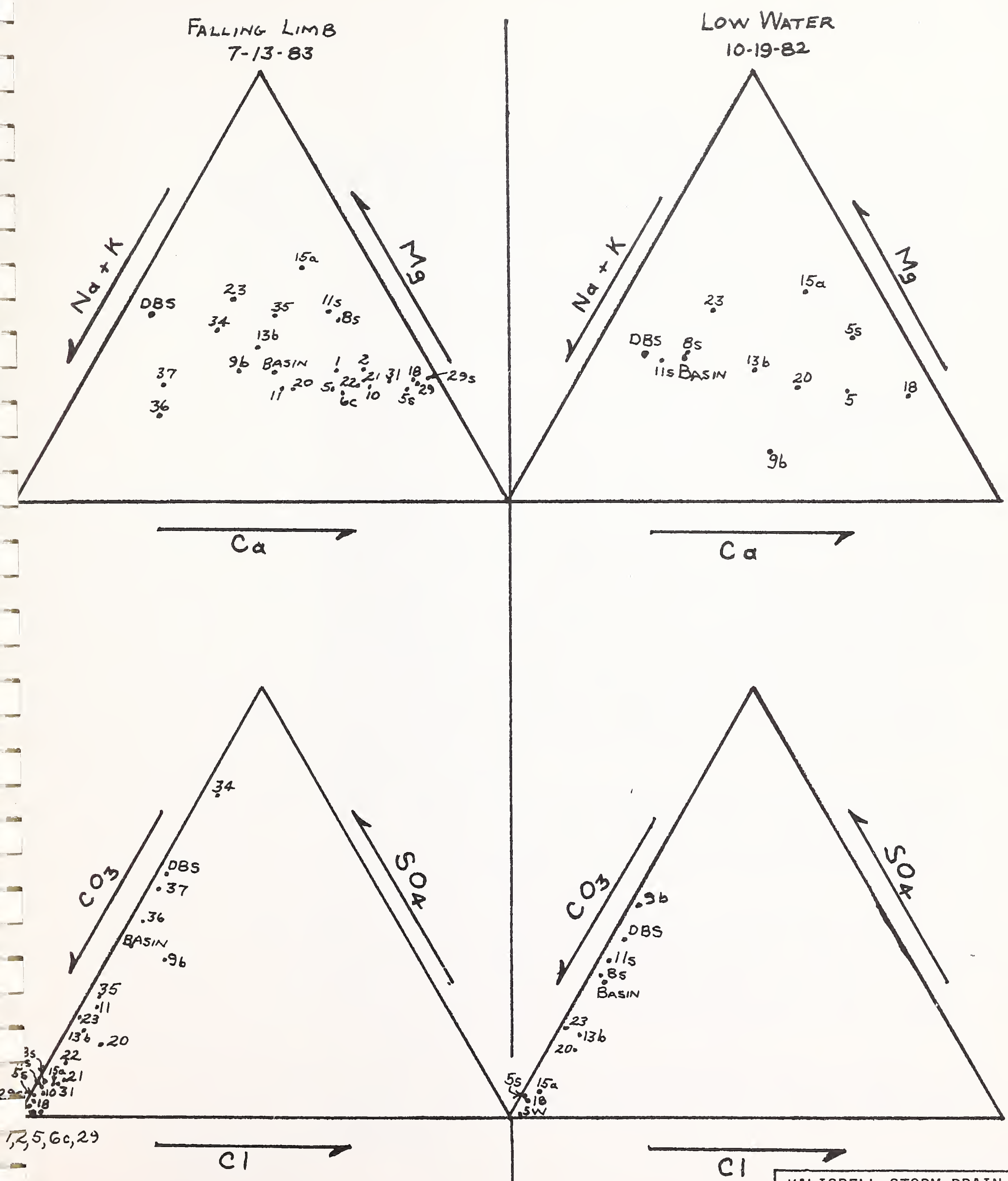
vary in each situation. This indicates little if any significant contribution to the quality of groundwater by the basin storm water.

b) The surface water ions above the basin (5s) are stable throughout the cycle, while below the basin the composition varies. The basin water changes independently from the creek water below the basin. This indicates the composition of the creek water below the basin is affected by a combination of Dry Bridge Slough Water, Basin water and other water sources.



KALISPELL STORM DRAIN
MF 6799(09)

Trilinear Diagrams
Figure 7



KALISPELL STORM DRAIN
MF 6799(09)

Trilinear Diagrams
Figure 8

CONCLUSIONS

The point source loading of the storm drain and detention basin constructed by the City of Kalispell and the Department is a recharge source to the shallow floodplain aquifer and the determination of the effect of this source is the major concern of this report. Our studies indicate:

1. No adverse effect is caused by the Kalispell Storm Drain System.
2. Good correlation exists between the Flathead-Stillwater River levels and the groundwater levels, indicating good hydrologic connection.
3. The groundwater flow in the Flathead-Stillwater floodplain is much higher than the flow in the other identified aquifers.
4. Significant groundwater mounding was not apparent in our measurements.
5. The stormwater chemistry of this project is similar to other stormwater chemistries (Spratt-1982).
6. Of the water quality parameters measured, only bacteria and iron concentrations exceed drinking water standards. No source for these parameters is identified. Sodium concentrations are high for the groundwater from the Dry Bridge Slough Aquifer.
7. Chemical sampling frequency could allow for undected chemical changes; however the 2½ years of repetitive sampling provide an adequate data base.
8. A small potentiometric and chemical "plume" was observed near the Dry Bridge Slough-Basin outfall area. The observations of this study indicate that the Dry Bridge Should Aquifer is the main source for this "plume".
9. Monitoring the inflow and outflow of the detention basin indicates the system is adequately designed. Storm water levels measured in the detention basin show that storm water is held for only a small portion of time; therefore only small amounts of infiltration occur.
10. The point source loading of the detention basin and outflow into Woodland Creek is being effectively treated in the swampy area downstream.

RECOMMENDATIONS

1. The wells and monitoring points that are presently maintained should be monitored biannually with the field monitoring equipment. The tests should include groundwater elevation, specific conductance, pH and temperature along with precipitation records. This data can be obtained at a low cost and should provide information that can be correlated with this study.

2. The basin is presently collecting sediments at a rate of about 65 cubic yards per year. It should be cleaned out when it has collected about 10% of its total volume. The recommended cleanout interval is 8 years.

3. Proper maintenance is required for the constriction in the flow system at Willow Glen Drive and for the flow regulation at the detention basin outflow.

4. This study has provided the Department with the capabilities of evaluating potential problems involving water quality. We recommend studies be undertaken during a projects design phase to properly evaluate potential water quality affects. We feel such monitoring to provide background data could be accomplished with much less cost if done during the design phase.

5. This study shows the hydraulic design to be adequate. The data indicates the water quality and impact from the storm drain system is insignificant to the Flathead-Stillwater floodplain. We, therefore, recommend the Kalispell Storm Drain system be turned over to the City of Kalispell in accordance with the orignal agreement.

sk/209a

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Vol. II - Report No. FHWA/RD-81/043,
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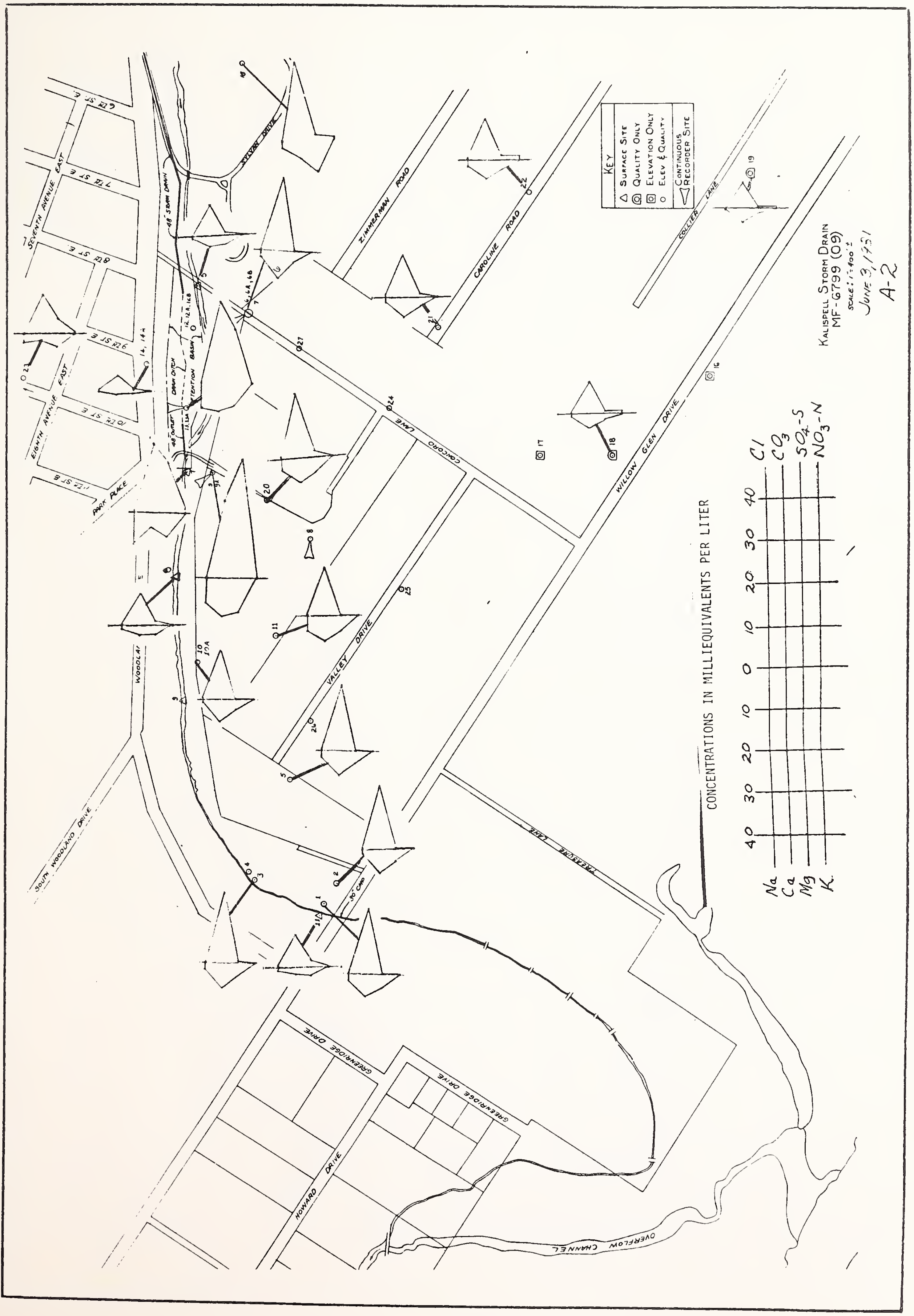
APPENDIX A

CHEMICAL STIFF DIAGRAMS
FOR THE
KALISPELL STORM DRAIN MONITORING PROJECT
MF 6799(09)

JA/sk/211


Kalispell Storm Drain
MF-6799 (09)
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June 3, 1975
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◎ Quality Only
◻ Elevation Only
○ Elev & Quality
◁ Continuous Recorder Site
Concentrations in milliequivalents per liter
Na
Ca
Mg
K
Cl
CO3
SO4-S
NO3-N
40
30
20
10
0
10
20
30
40
Seventh Avenue East
Eighth Avenue East
6th St E
7th St E
8th St E
9th St E
10th St E
11th St E
Park Place
Woodland
South Woodland Drive
Sylvan Drive
Zimmerman Road
Caroline Road
Collier Lane
Concord Lane
Willow Glen Drive
Valley Drive
Treasure Lane
Greenridge Drive
Howard Drive
Overflow Channel
48" Storm Drain
48" Outlet
Drain Ditch
Detention Basin
30" CMP
1
2
3
4
5
6, 6A, 6B
7
8
9
9A
10, 10A
11
12, 12A, 12B
13, 13A
14, 14A
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22
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27

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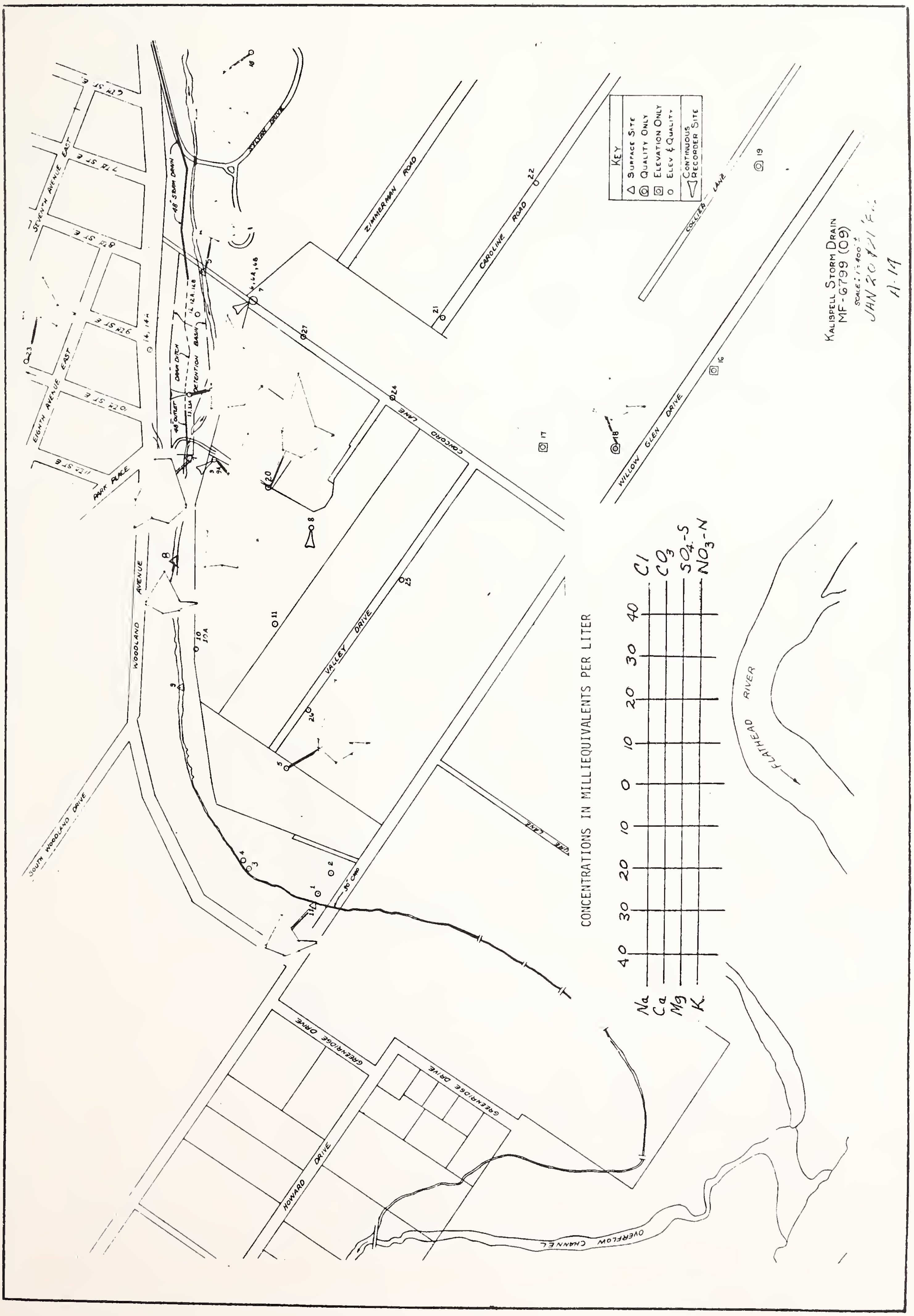
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⊡ Elevation Only
○ Elev & Quality
◁ Continuous Recorder Site
Kalispell Storm Drain
MF-6799 (09)
Scale: 1" = 400' ±
JAN 20 '71
A-14
CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER
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Ca
Mg
K
Cl
CO3
SO4-S
NO3-N
40
30
20
10
0
10
20
30
40
6th St E
7th St E
8th St E
9th St E
10th St E
11th St E
Seventh Avenue East
Eighth Avenue East
Park Place
Woodland Avenue
South Woodland Drive
Sylvan Drive
48" Storm Drain
Drain Ditch
Detention Basin
48" Outlet
Zimmerman Road
Caroline Road
Concord Lane
Valley Drive
Willow Glen Drive
Collier Lane
Greenridge Drive
Howard Drive
Overflow Channel
Flathead River
30" CMP
6, 6A, 6B
12, 12A, 12B
13, 13A
14, 14A
10, 10A
9, 9A
1
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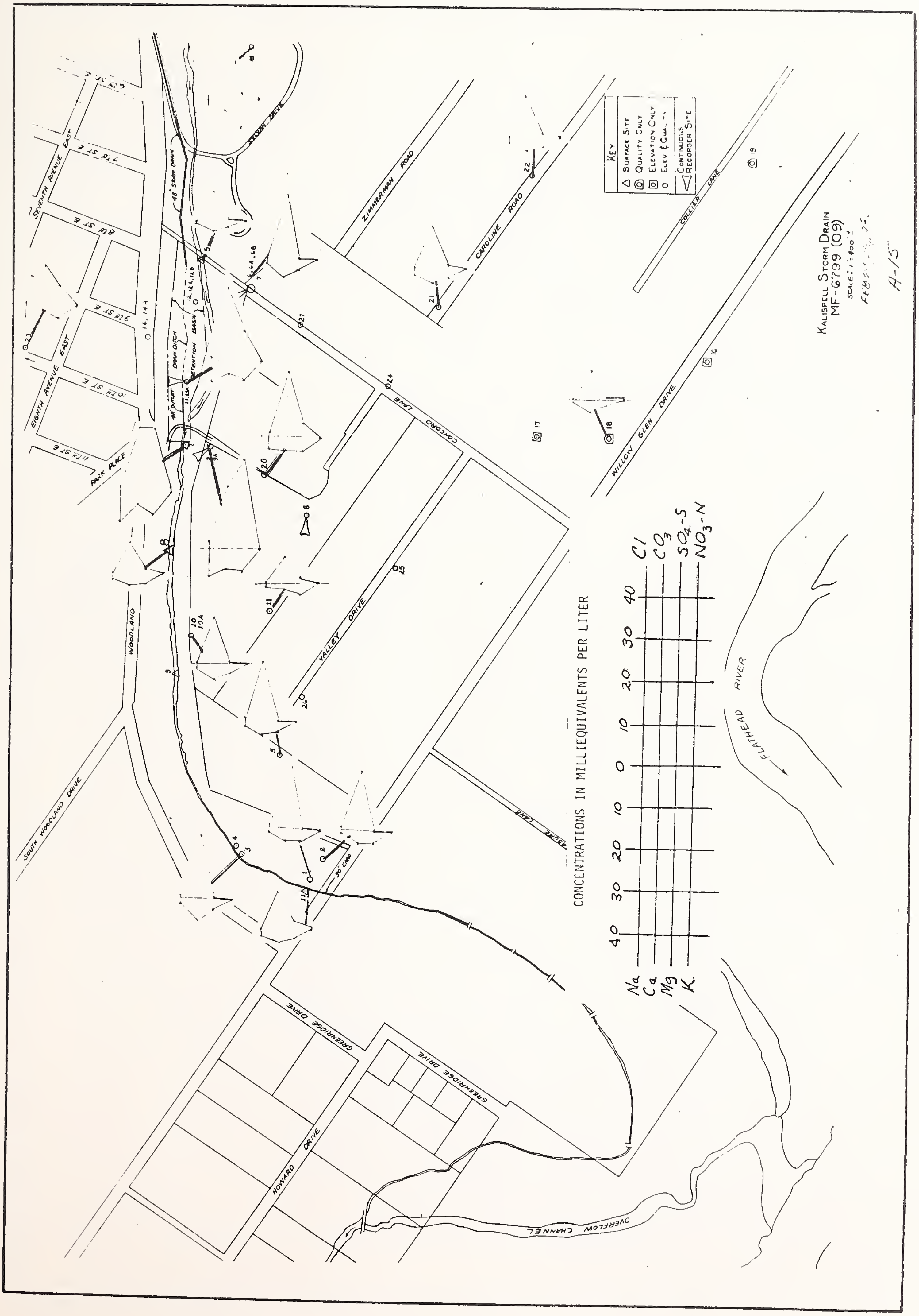
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▣ ELEVATION ONLY
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◁ CONTINUOUS RECORDER SITE
KALISPELL STORM DRAIN
MF-6799 (09)
SCALE: 1" = 400'±
A-15
CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER
Na
Ca
Mg
K
Cl
CO3
SO4-S
NO3-N
40 30 20 10 0 10 20 30 40
SEVENTH AVENUE EAST
EIGHTH AVENUE EAST
7TH ST E
8TH ST E
9TH ST E
10TH ST E
11TH ST E
PARK PLACE
WOODLAND
SOUTH WOODLAND DRIVE
SYLVAN DRIVE
ZIMMERMAN ROAD
CAROLINE ROAD
COLLIER LANE
WILLOW GLEN DRIVE
CONCORD LANE
VALLEY DRIVE
GREENRIDGE DRIVE
HOWARD DRIVE
OVERFLOW CHANNEL
FLATHEAD RIVER
48" STORM DRAIN
DRAIN DITCH
DETENTION BASIN
48" OUTLET
30" CMP
1
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5'
6A, 6B
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9A
10, 10A
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11'
12, 12A, 12B
13, 13A
14, 14A
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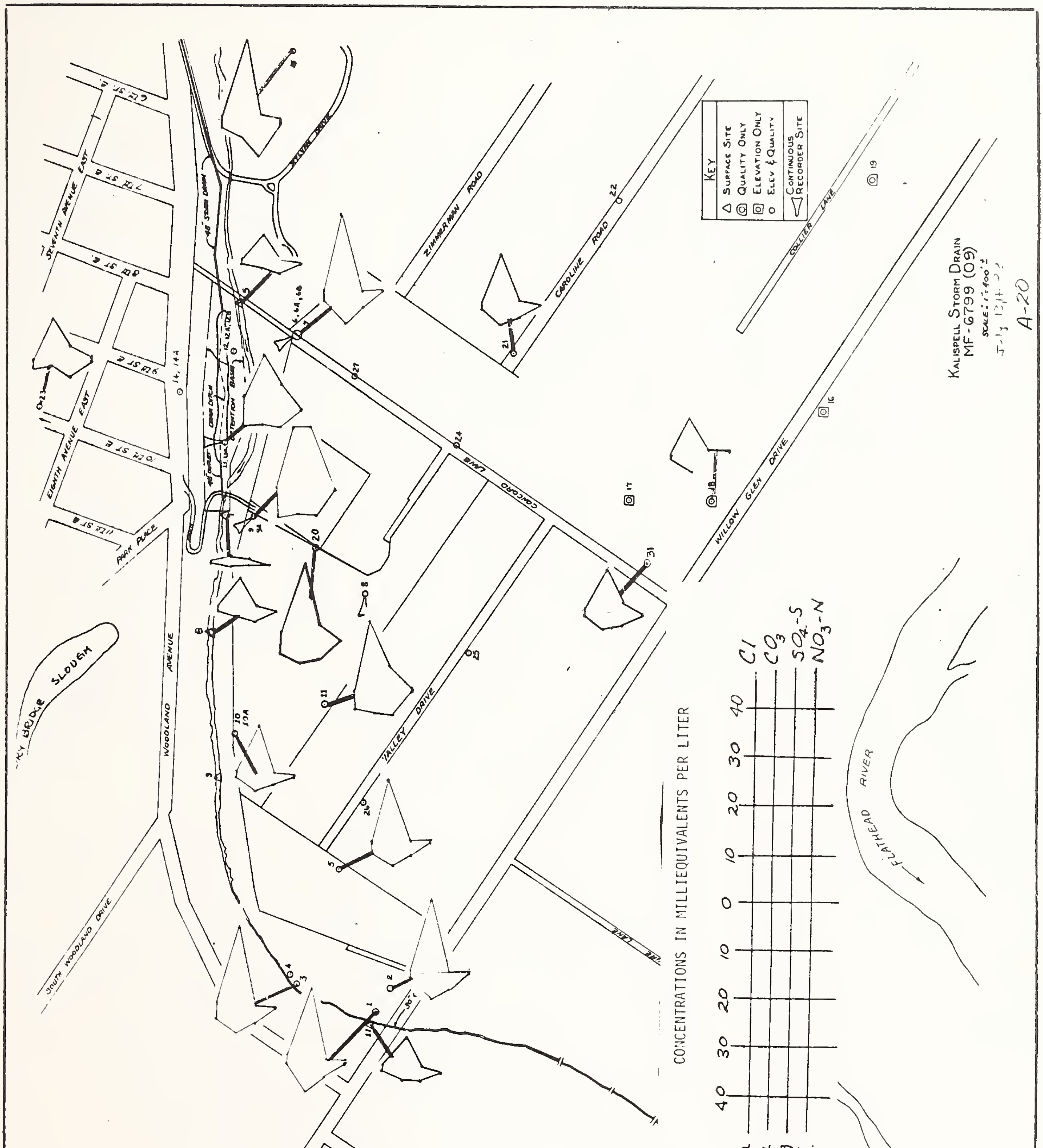
B

- 39 -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○ ELEV & QUALITY
◁ CONTINUOUS RECORDER SITE
CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER
Na
Ca
Mg
K
Cl
CO_3
SO_4-S
NO_3-N
40
30
20
10
0
10
20
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40
SEVENTH AVENUE EAST
EIGHTH AVENUE EAST
PARK PLACE
WOODLAND AVENUE
SOUTH WOODLAND DRIVE
BRIDGE SLOUGH
ZIMMERMAN ROAD
CAROLINE ROAD
CONCORD LANE
VALLEY DRIVE
WILLOW GLEN DRIVE
COLLIER LANE
GREENRIDGE DRIVE
HOWARD DRIVE
OVERFLOW CHANNEL
FLATHEAD RIVER
48" STORM DRAIN
OPEN DITCH
DETENTION BASIN
OUTLET
6TH ST E
7TH ST E
8TH ST E
9TH ST E
10TH ST E
11TH ST E
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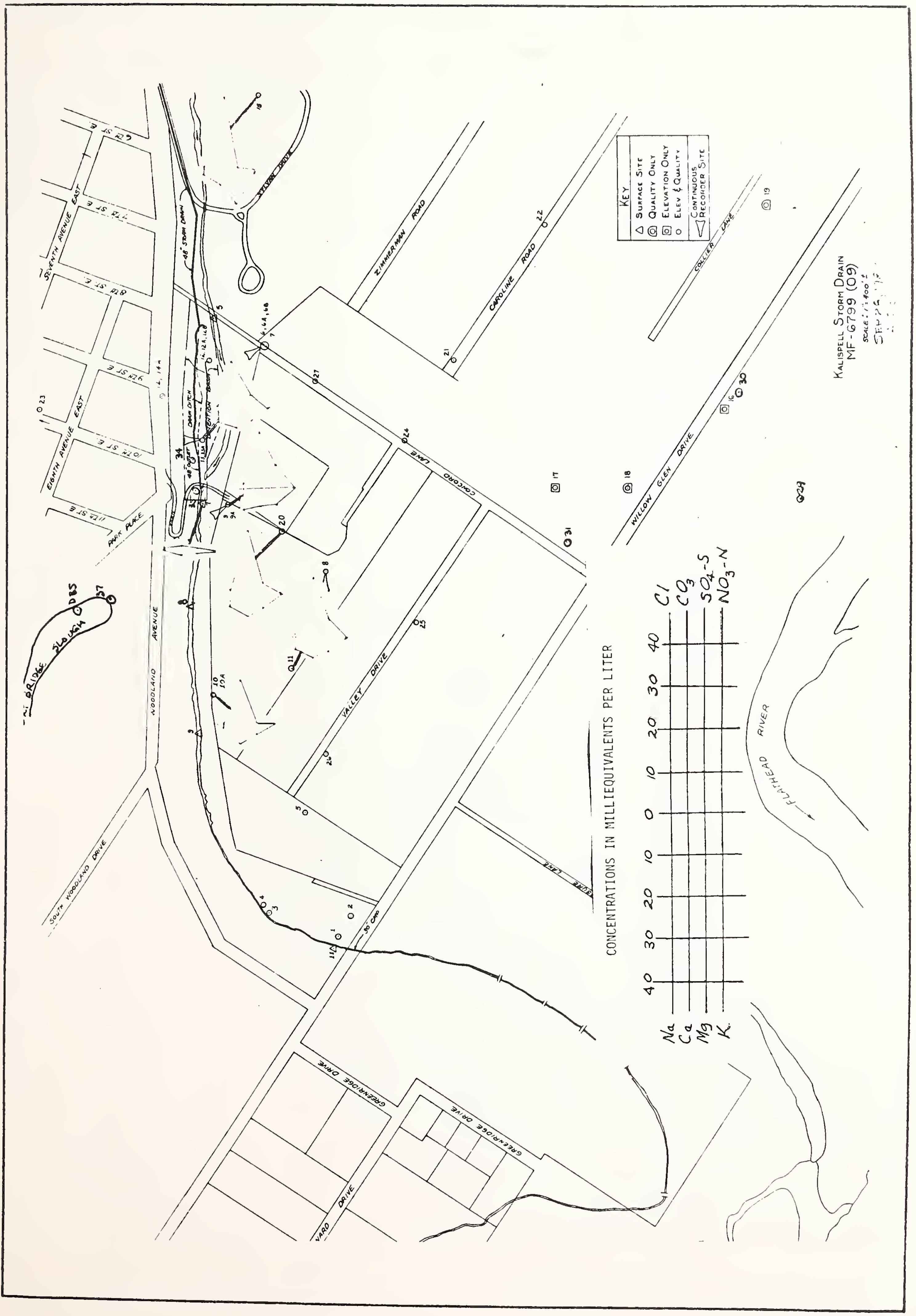
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Continuous Recorder Site
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Ca
Mg
K
Cl
CO3
SO4-S
NO3-N
40
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Woodland Avenue
South Woodland Drive
Seventh Avenue East
Eighth Avenue East
Park Place
6th St E
7th St E
8th St E
9th St E
10th St E
11th St E
Sylvan Drive
Zimmerman Road
Caroline Road
Concord Lane
Valley Drive
Willow Glen Drive
Collier Lane
Greenridge Drive
Flathead River
48" Storm Drain
Drain Ditch
Detention Basin
48" Outlet
30" CMP
Bridge Slough
DBS
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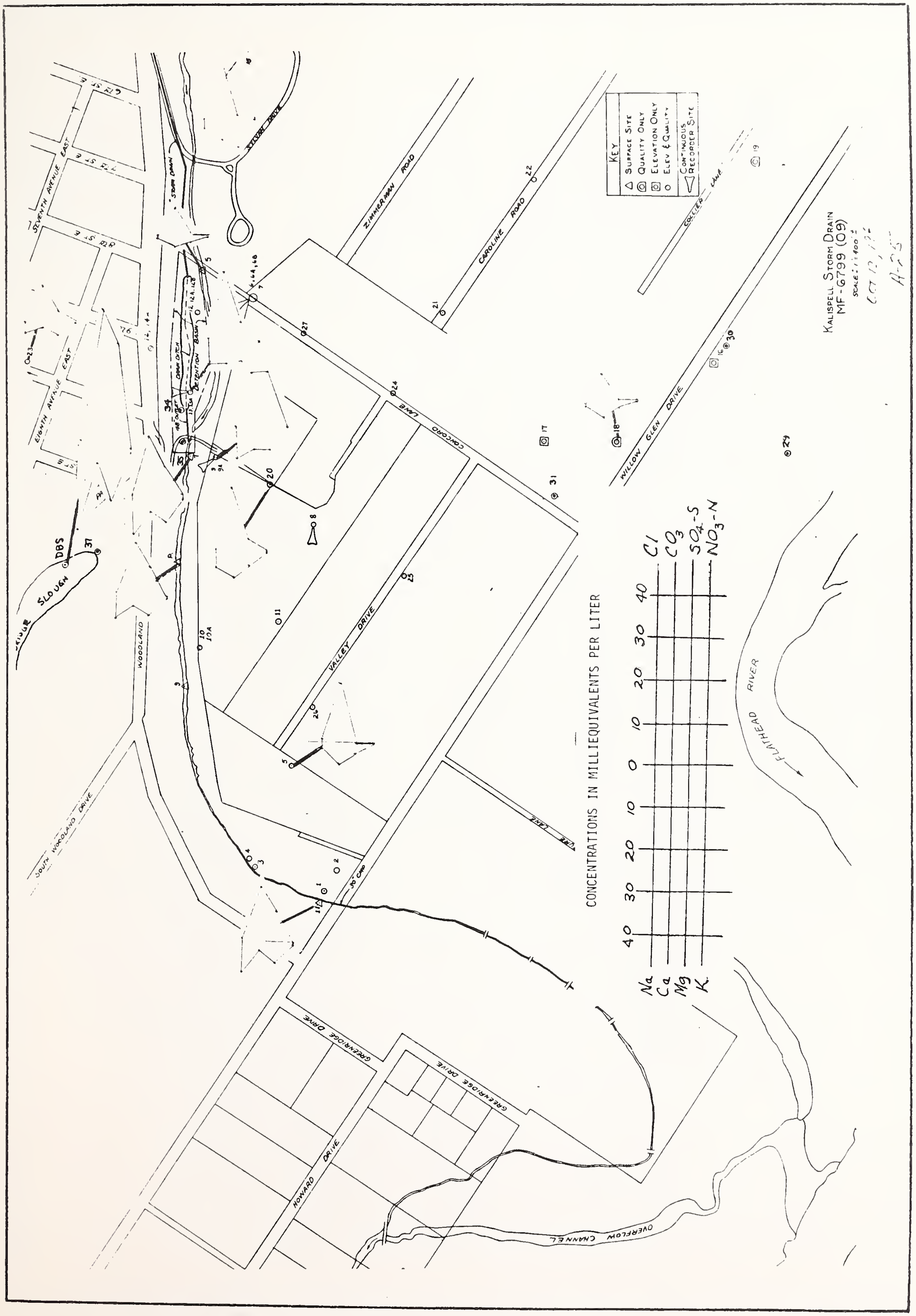
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▣ Elevation Only
○ Elev & Quality
Continuous Recorder Site
Concentrations in milliequivalents per liter
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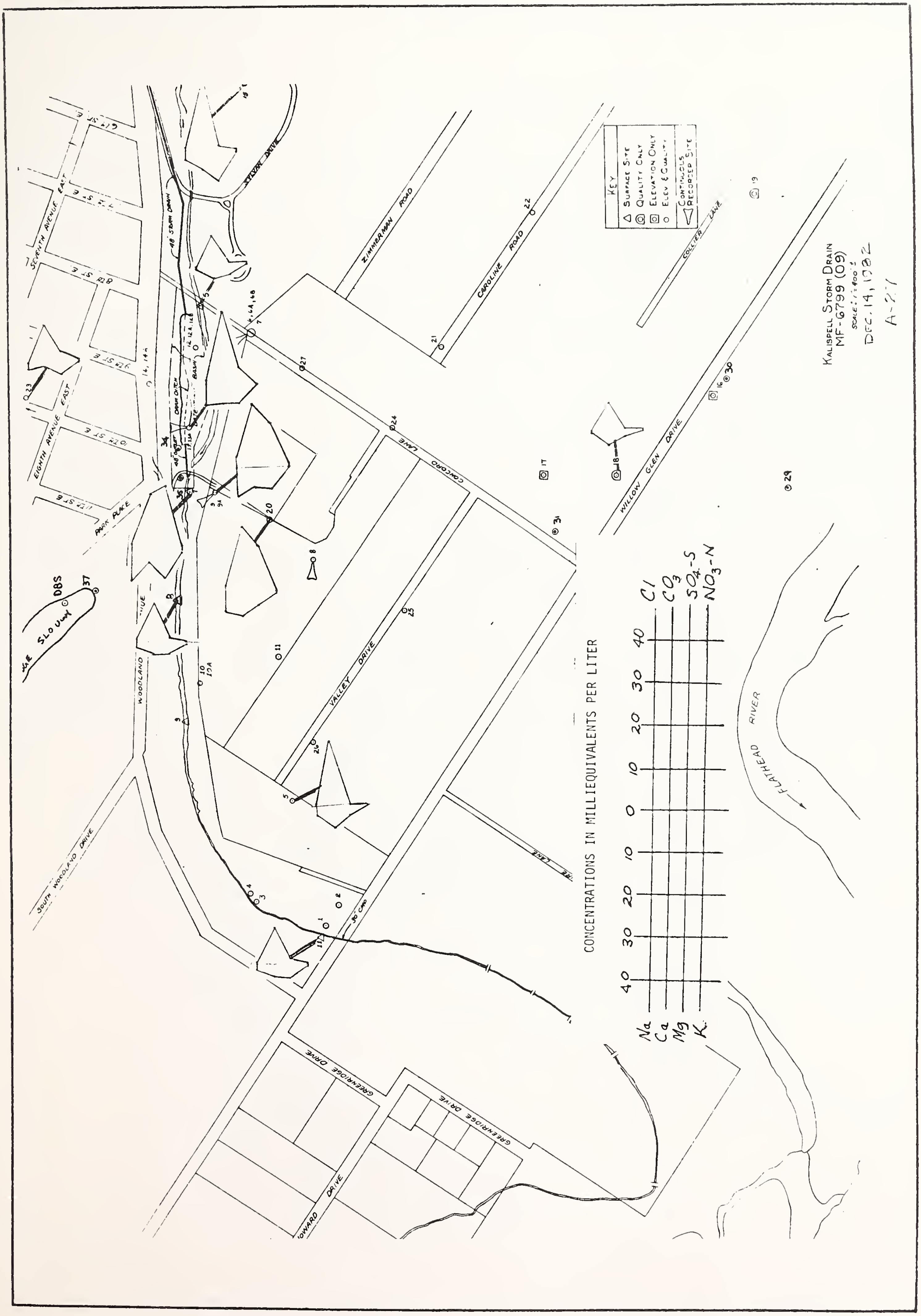
Na
Ca
Mg
K
Cl
CO3
SO4-S
NO3-N
Seventh Avenue East
Eighth Avenue East
South Woodland Drive
Woodland
Zimmerman Road
Caroline Road
Collier Lane
Willow Glen Drive
Concord Lane
Valley Drive
Greenridge Drive
Howard Drive
Overflow Channel
Flathead River
Ridge Slough
Sylvan Drive
Storm Drain
Detention Basin
Drain Ditch
DBS
30" CMP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KALISPELL STORM DRAIN
MF-6799 (09)
SCALE: 1"=400'±
DEC. 14, 1982
A-27
CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER
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NO3-N
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EIGHTH AVENUE EAST
PARK PLACE
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SOUTH WOODLAND DRIVE
SYLVAN DRIVE
ZIMMERMAN ROAD
CAROLINE ROAD
CONCORD LANE
VALLEY DRIVE
WILLOW GLEN DRIVE
COLLIER LANE
GREENRIDGE DRIVE
HOWARD DRIVE
FLATHEAD RIVER
SLOUGH
DBS
48" STORM DRAIN
DRAIN DITCH
BASIN
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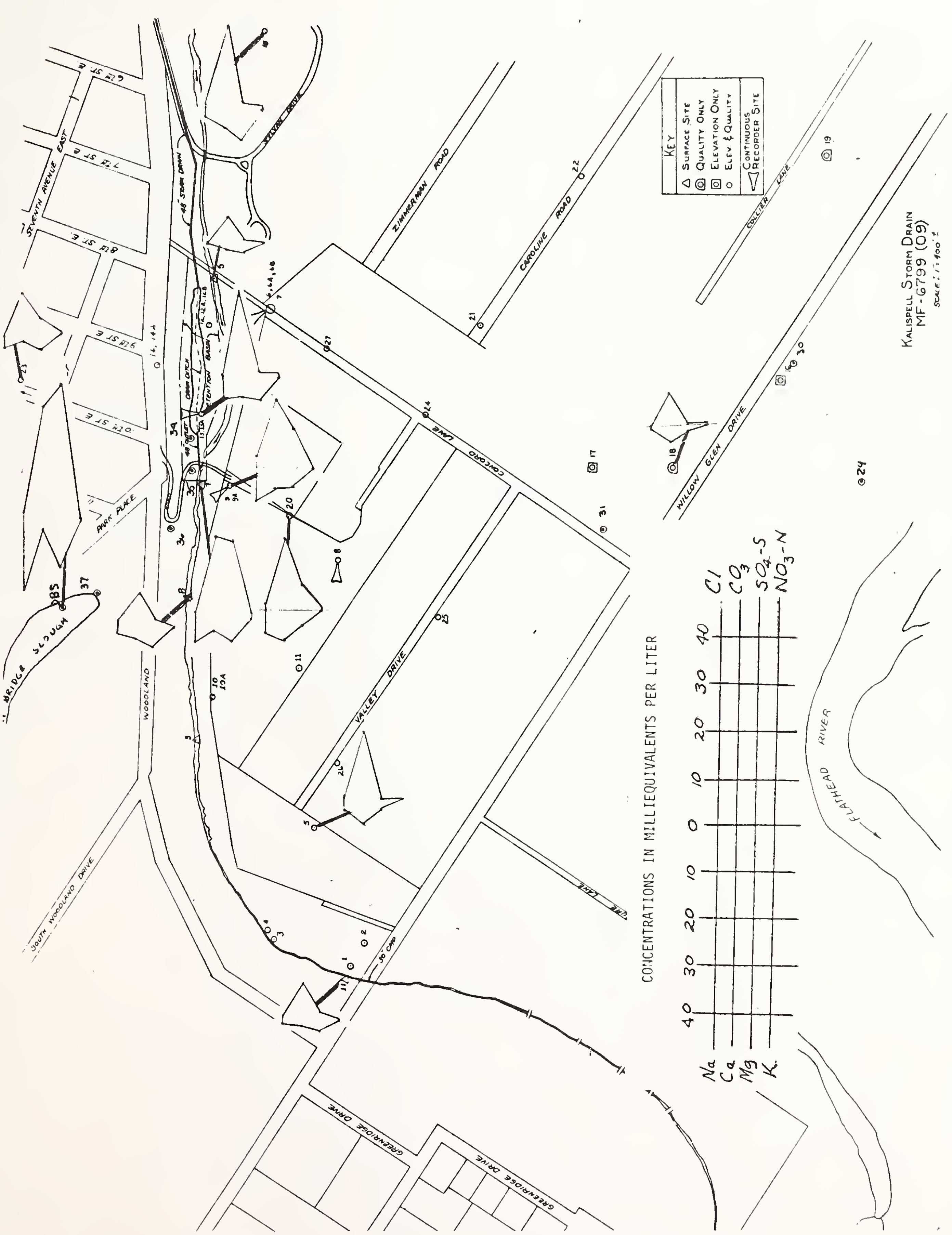
Kalispell Storm Drain
MF-6799 (09)
Scale: 1" = 400'±
May 18, 1983
A-35
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○ Elev & Quality
Continuous Recorder Site
CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER
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NO3-N
Seventh Avenue East
6th St E
7th St E
8th St E
9th St E
10th St E
Park Place
48" Storm Drain
Drain Ditch
Detention Basin
48" Outlet
Sylvan Drive
Zimmerman Road
Caroline Road
Collier Lane
Willow Glen Drive
Concord Lane
Valley Drive
Woodland
South Woodland Drive
Bridge Slough
Flathead River
Greenridge Drive
30" CMP
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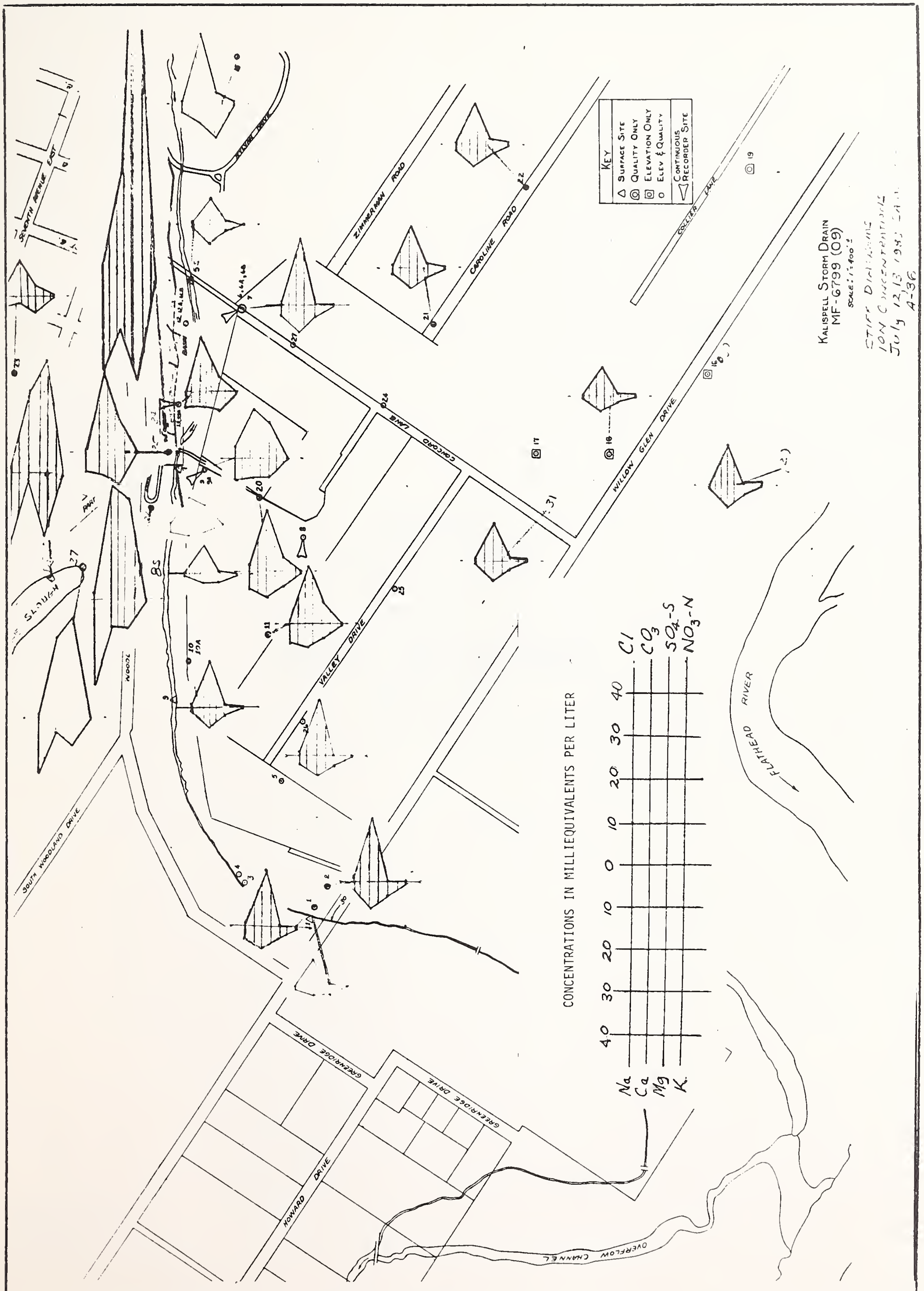
KALISPELL STORM DRAIN
MF-6799 (09)
SCALE: 1:1400±
STIFF DIAGRAMS
ION CONCENTRATIONS
July 12,13 1983
A-36
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▣ ELEVATION ONLY
○ ELEV & QUALITY
◁ CONTINUOUS RECORDER SITE
CONCENTRATIONS IN MILLIEQUIVALENTS PER LITER
40 30 20 10 0 10 20 30 40
Na Ca Mg K
Cl CO3 SO4-S NO3-N
SEVENTH AVENUE EAST
SOUTH WOODLAND DRIVE
WOODL
SLOUGH
VALLEY DRIVE
CONCORD LANE
ZIMMERMAN ROAD
CAROLINE ROAD
COLLIER LANE
WILLOW GLEN DRIVE
FLATHEAD RIVER
OVERFLOW CHANNEL
GREENRIDGE DRIVE
GREENRIDGE DRIVE
HOWARD DRIVE
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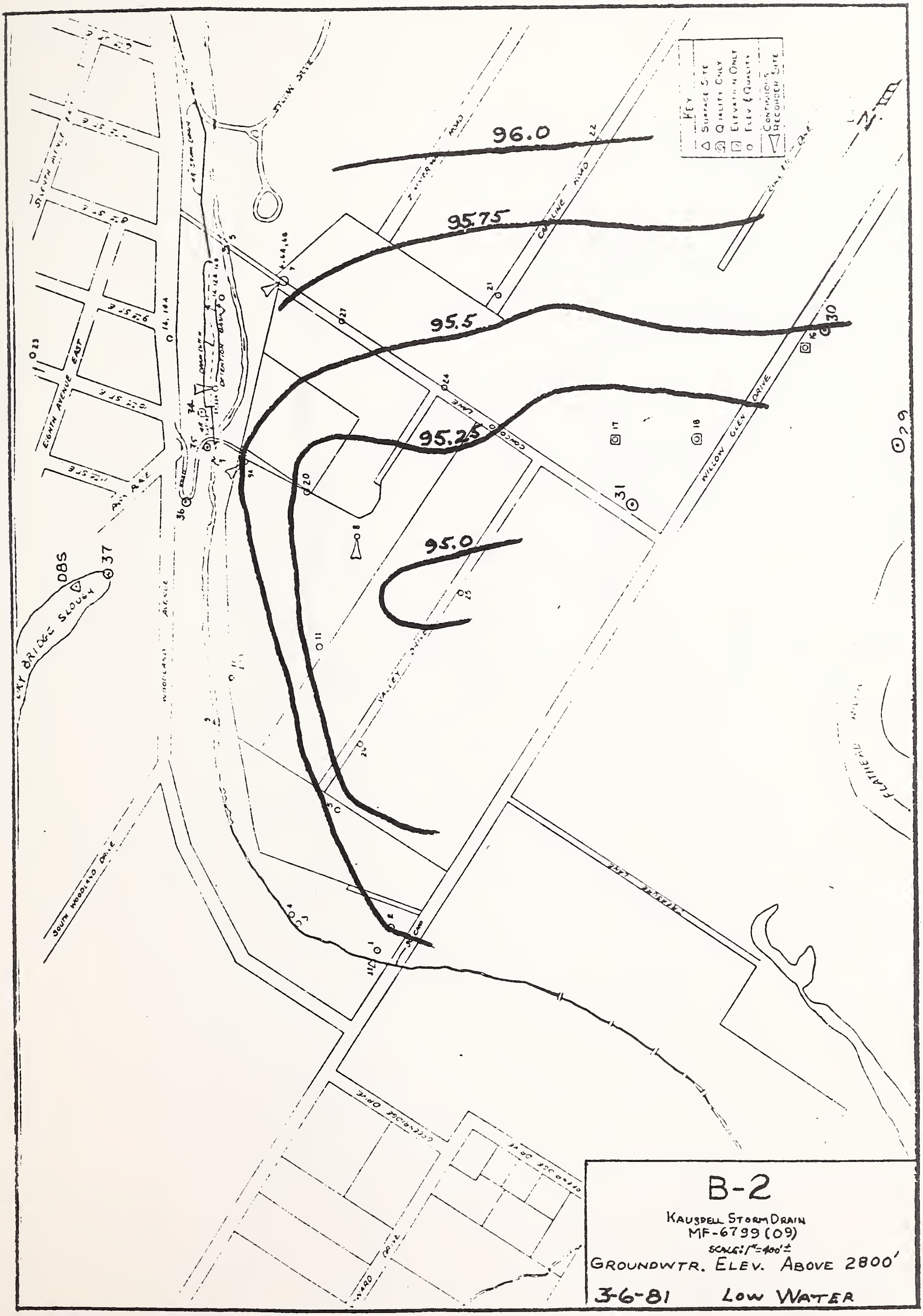
APPENDIX B

PIEZOMETRIC MAPPING
FOR THE
KALISPELL STORM DRAIN PROJECT

MF 6799(09)

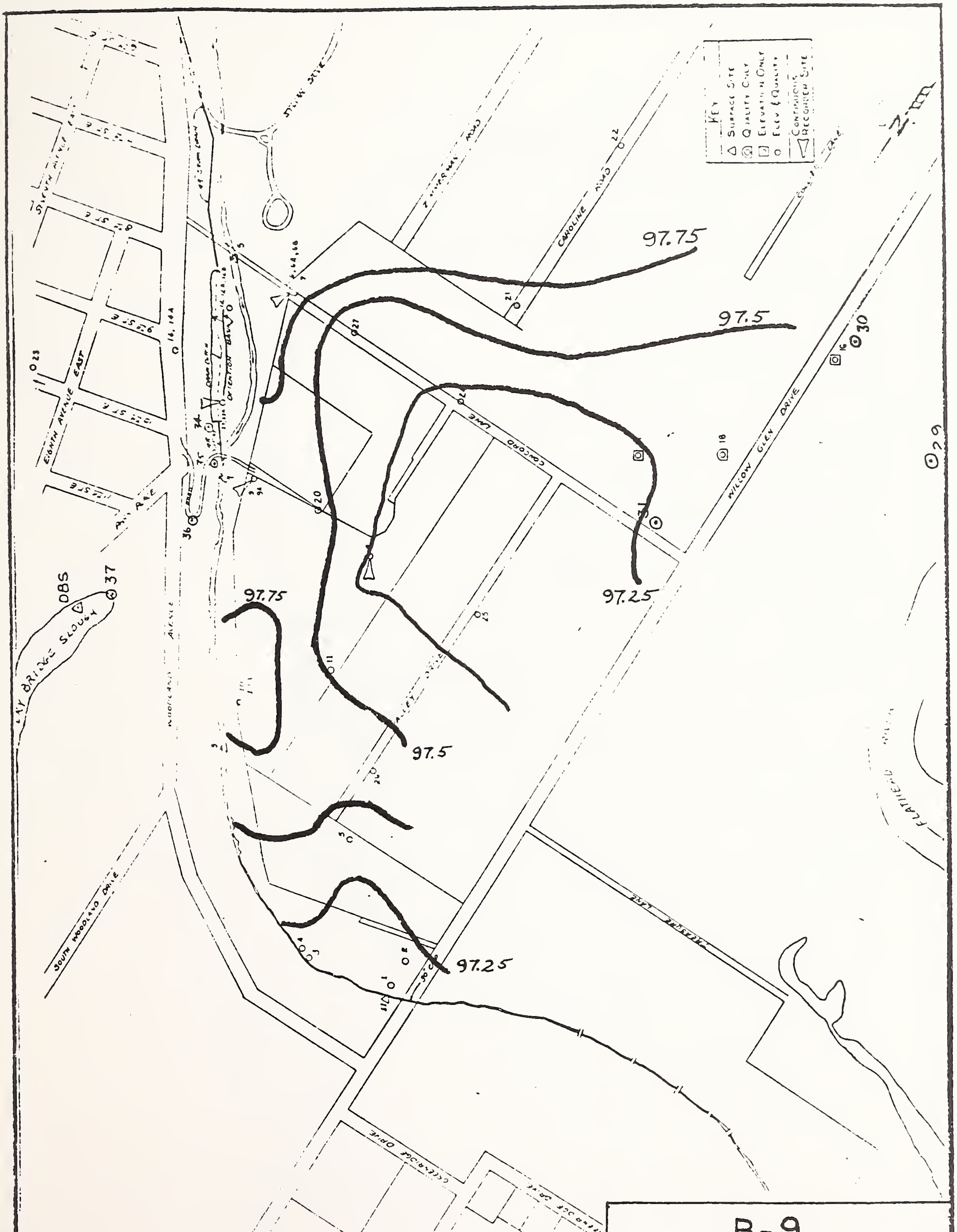
JA/sk/2112



B-2

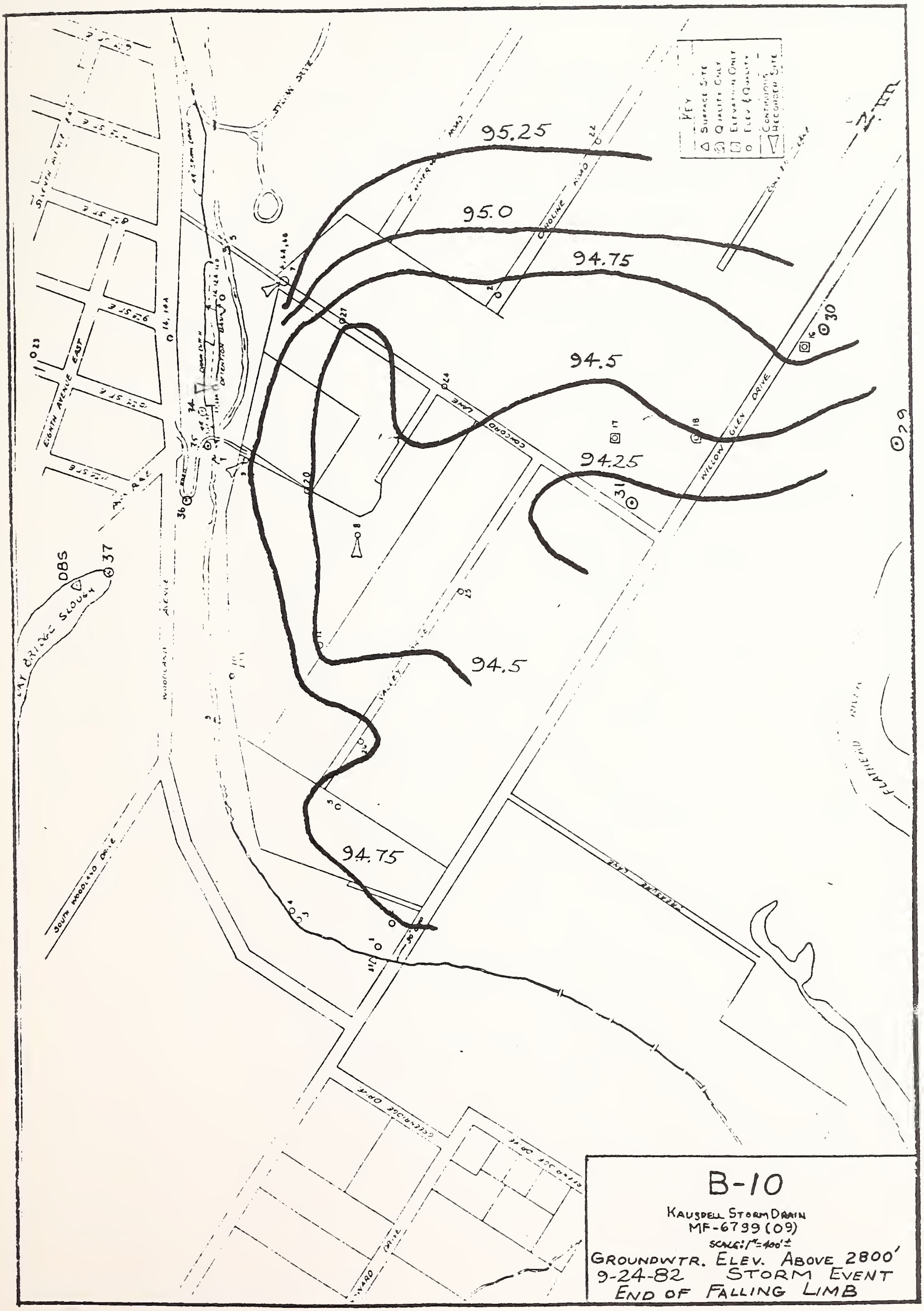
Kalispell Storm Drain
MF-6799 (09)
Scale: 1" = 400' ±
Groundwtr. Elev. Above 2800'

3-6-81 Low Water



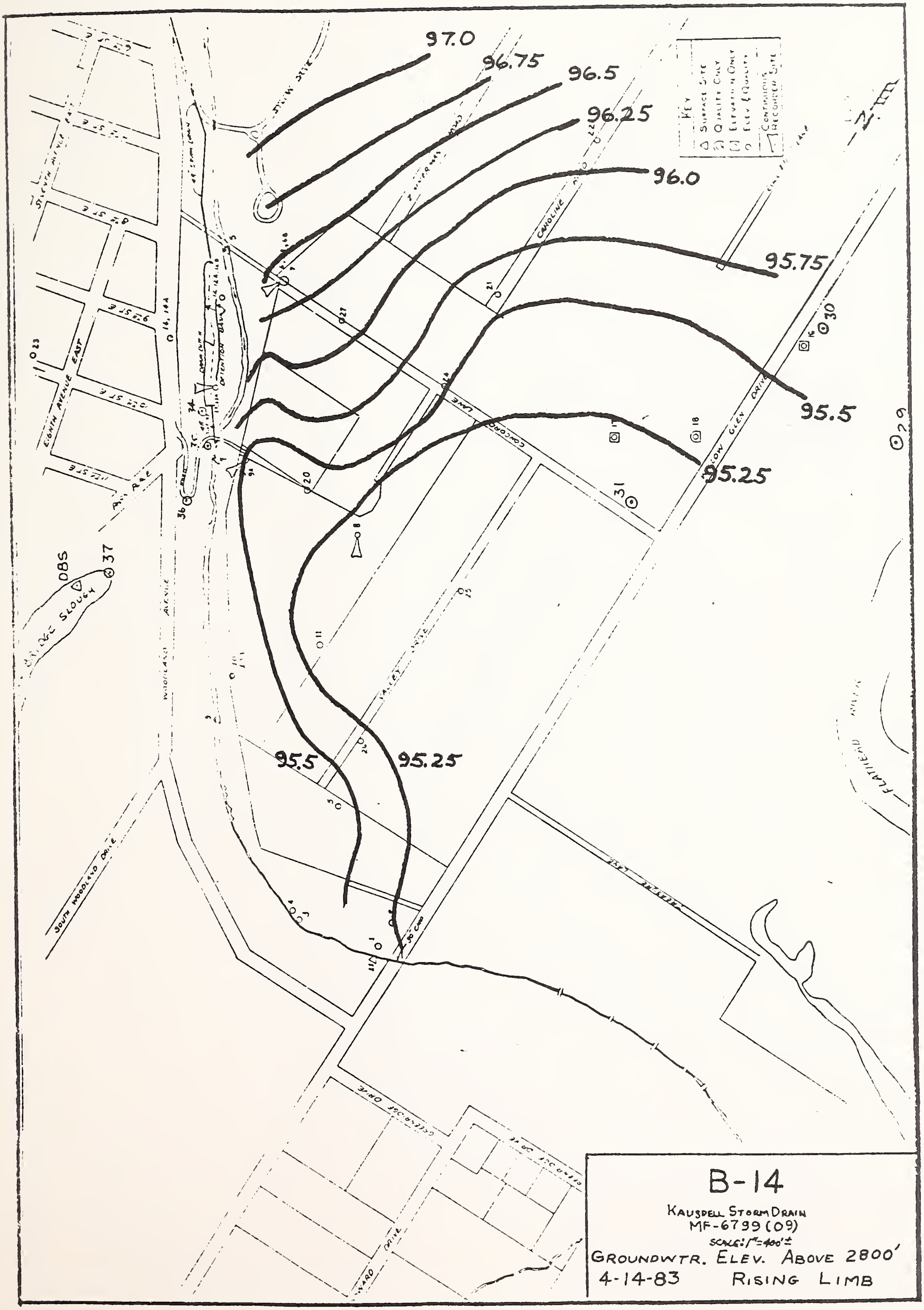
B-9

Kauspell StormDrain
MF-6799 (09)
scale: 1"=400'±
Groundwtr. Elev. Above 2800'
7-13-82 Peak High Water



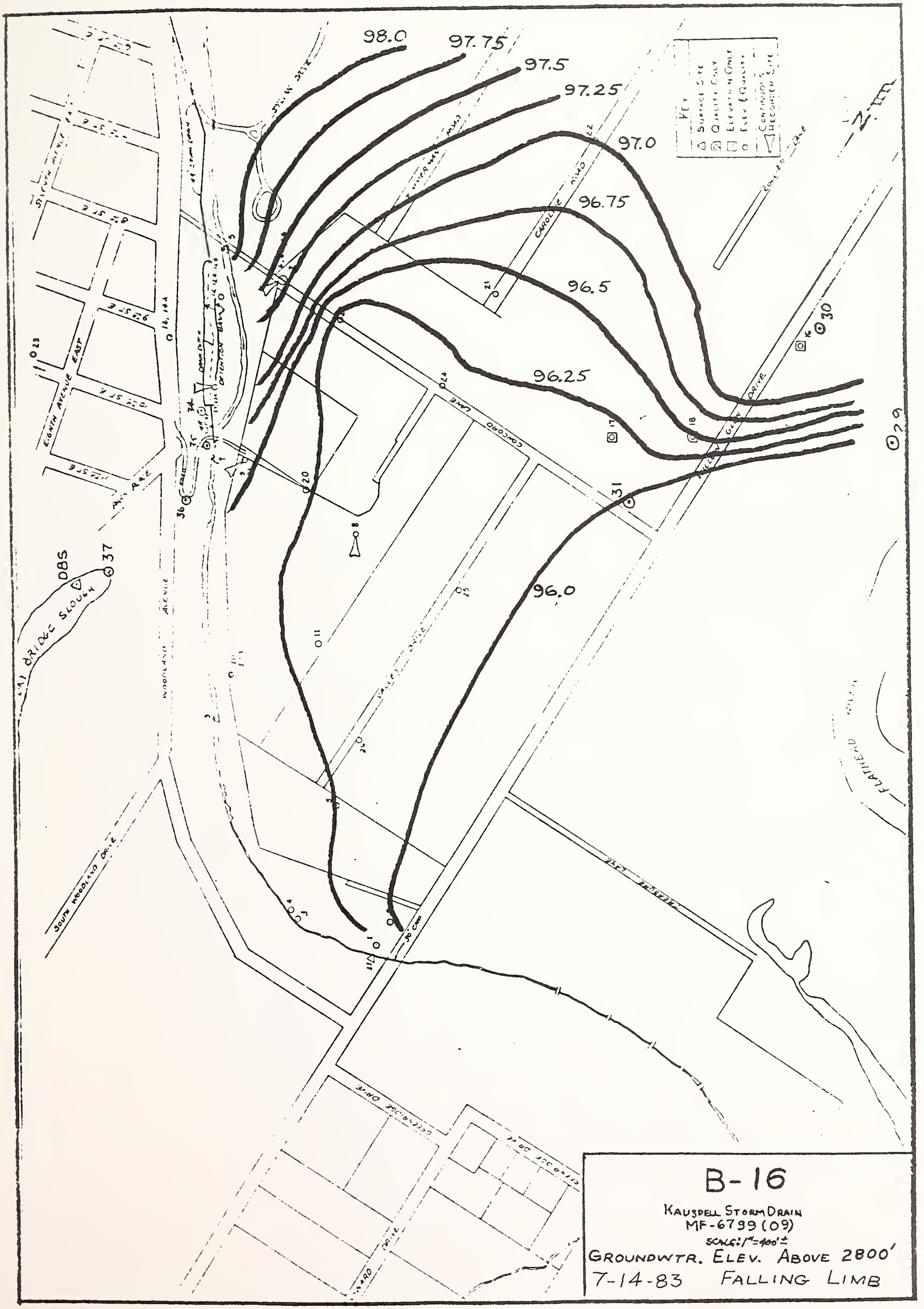
B-10

KAUSPELL STORM DRAIN
MF-6799 (09)
SCALE: 1" = 400' ±
GROUNDWTR. ELEV. ABOVE 2800'
9-24-82 STORM EVENT
END OF FALLING LIMB



B-14

Kauspell Storm Drain
MF-6799(09)
Scale: 1" = 400' ±
Groundwtr. Elev. Above 2800'
4-14-83 Rising Limb



B-16

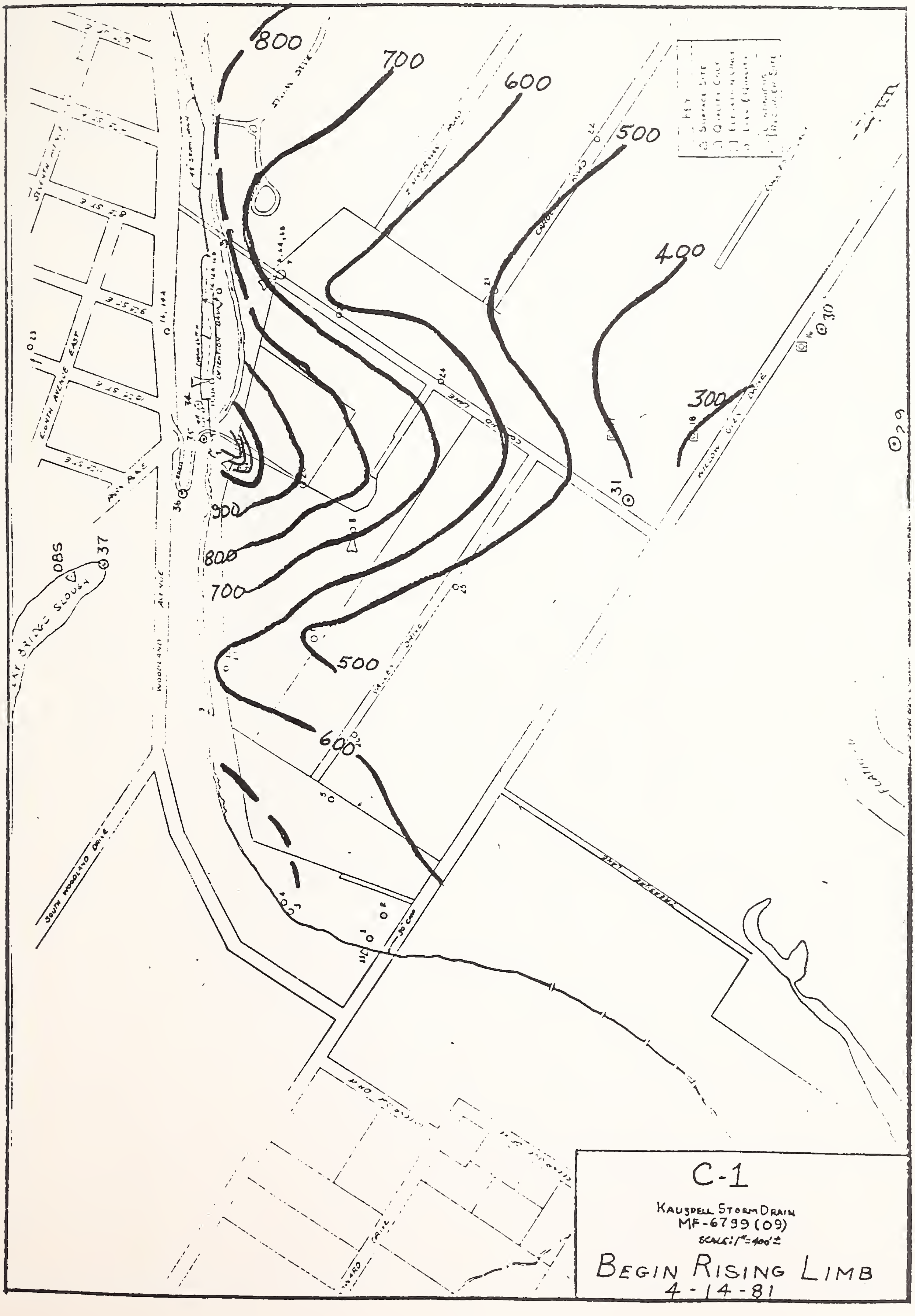
Kauspell Storm Drain
MF-6799 (09)
scale: 1"=400'±
Groundwtr. Elev. Above 2800'
7-14-83 Falling Limb

APPENDIX C

SPECIFIC CONDUCTANCE CONTOUR MAPS FOR THE KALISPELL STORM DRAIN MONITORING PROJECT

MF 6799(09)

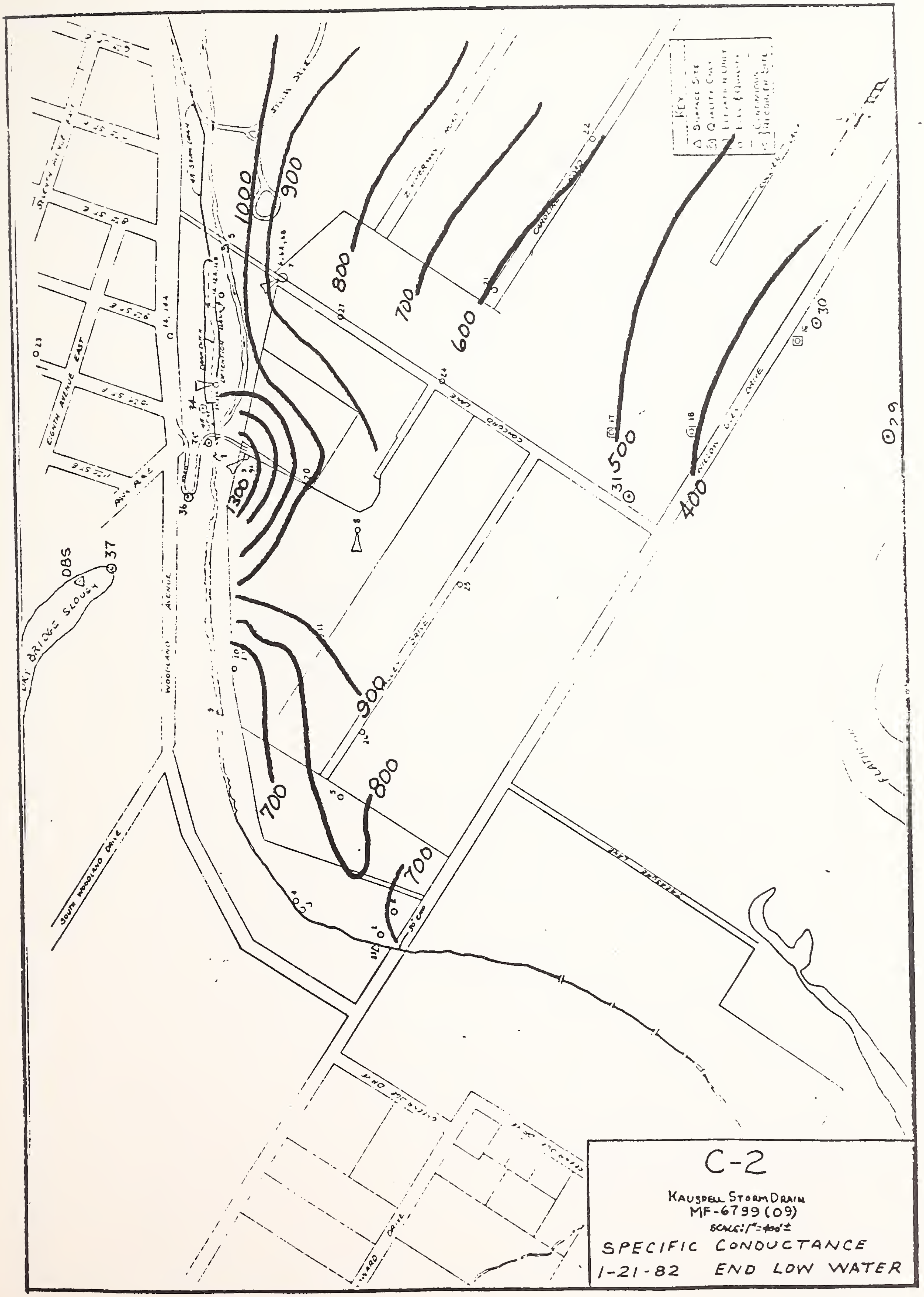
JA/sk/2113



C-1

Kauspell Storm Drain
MF-6799 (09)
Scale: 1"=400'±

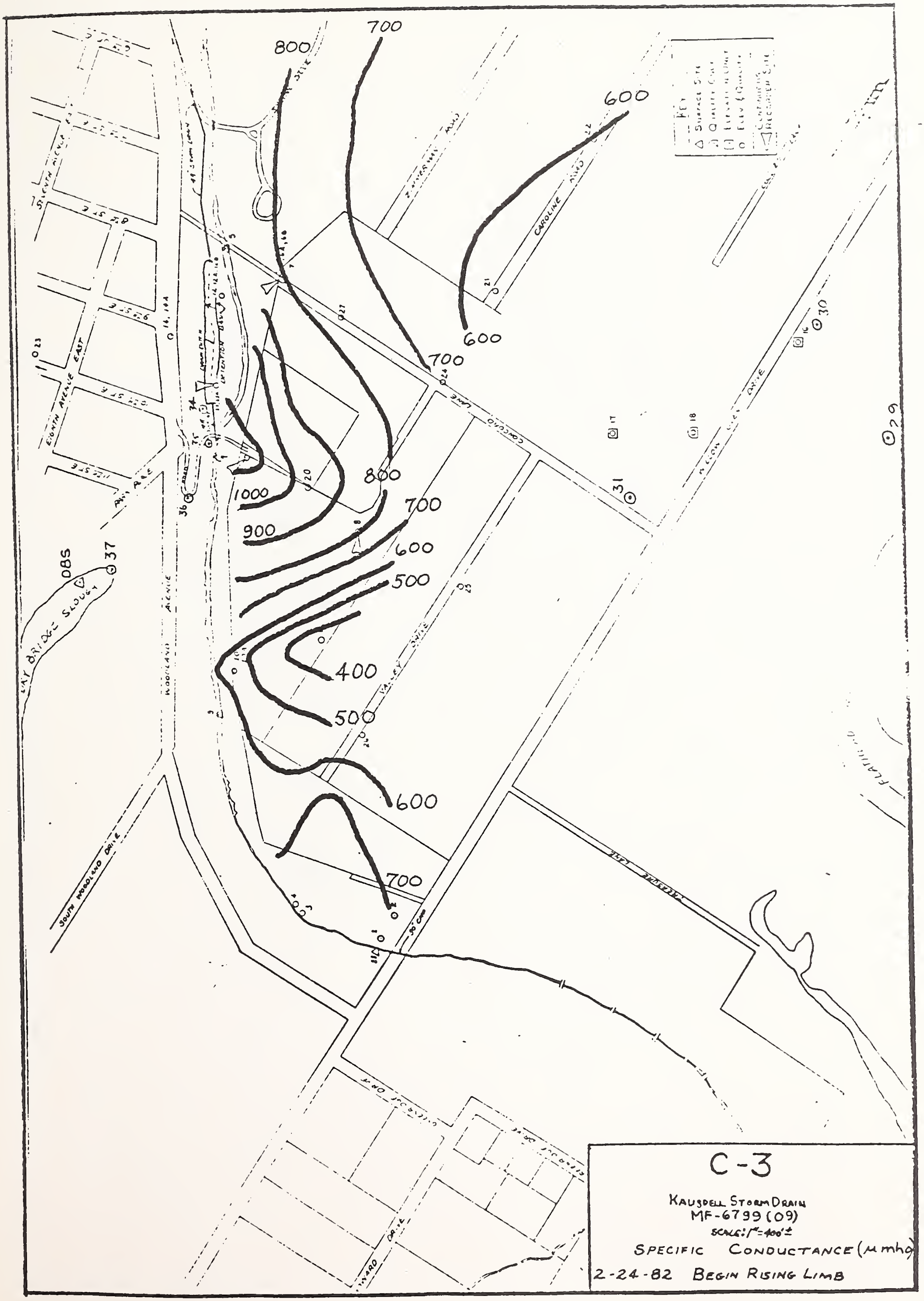
Begin Rising Limb
4-14-81



C-2

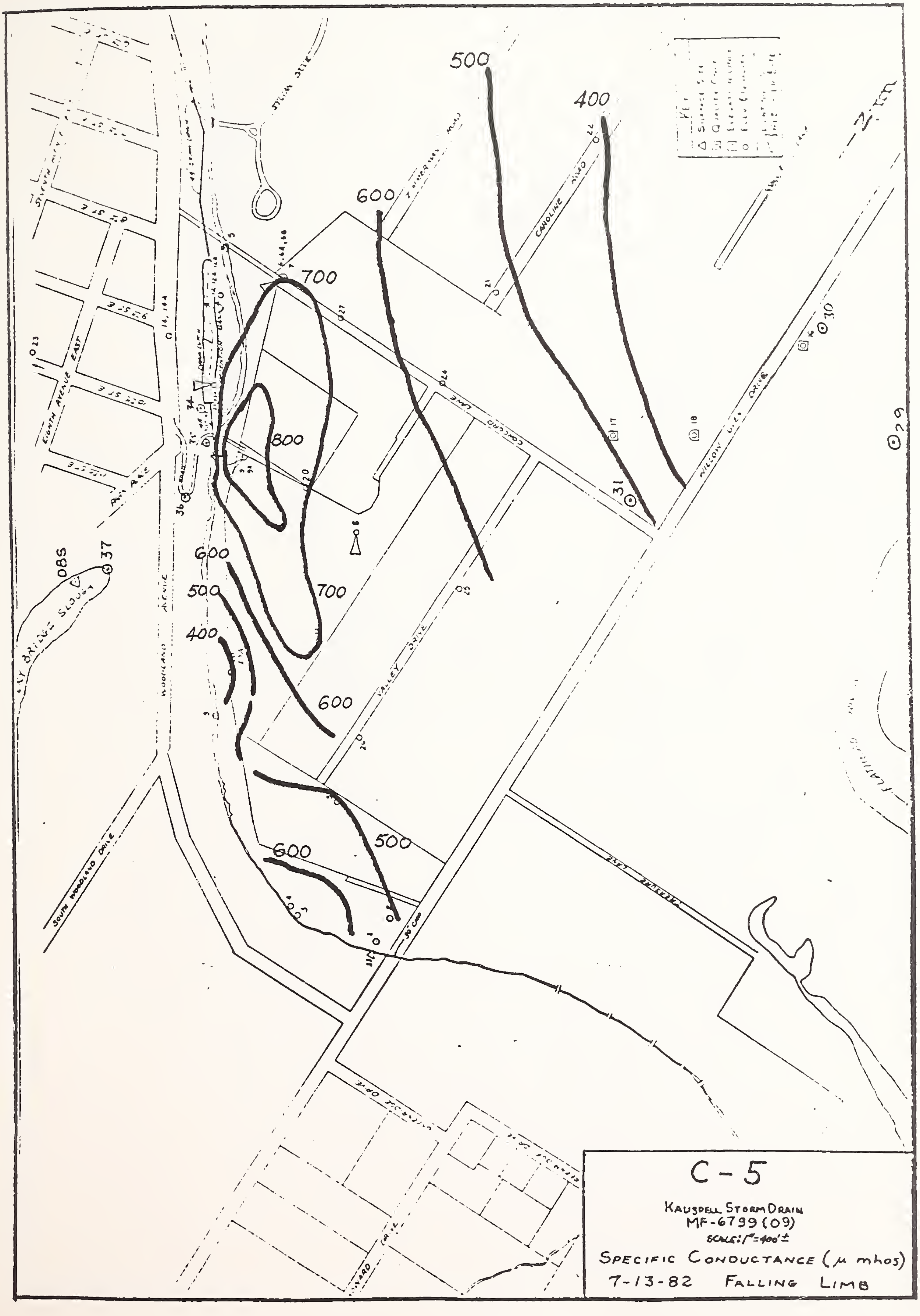
Kauspell Storm Drain
MF-6799 (09)
Scale: 1" = 400' ±

SPECIFIC CONDUCTANCE
1-21-82 END LOW WATER



C-3

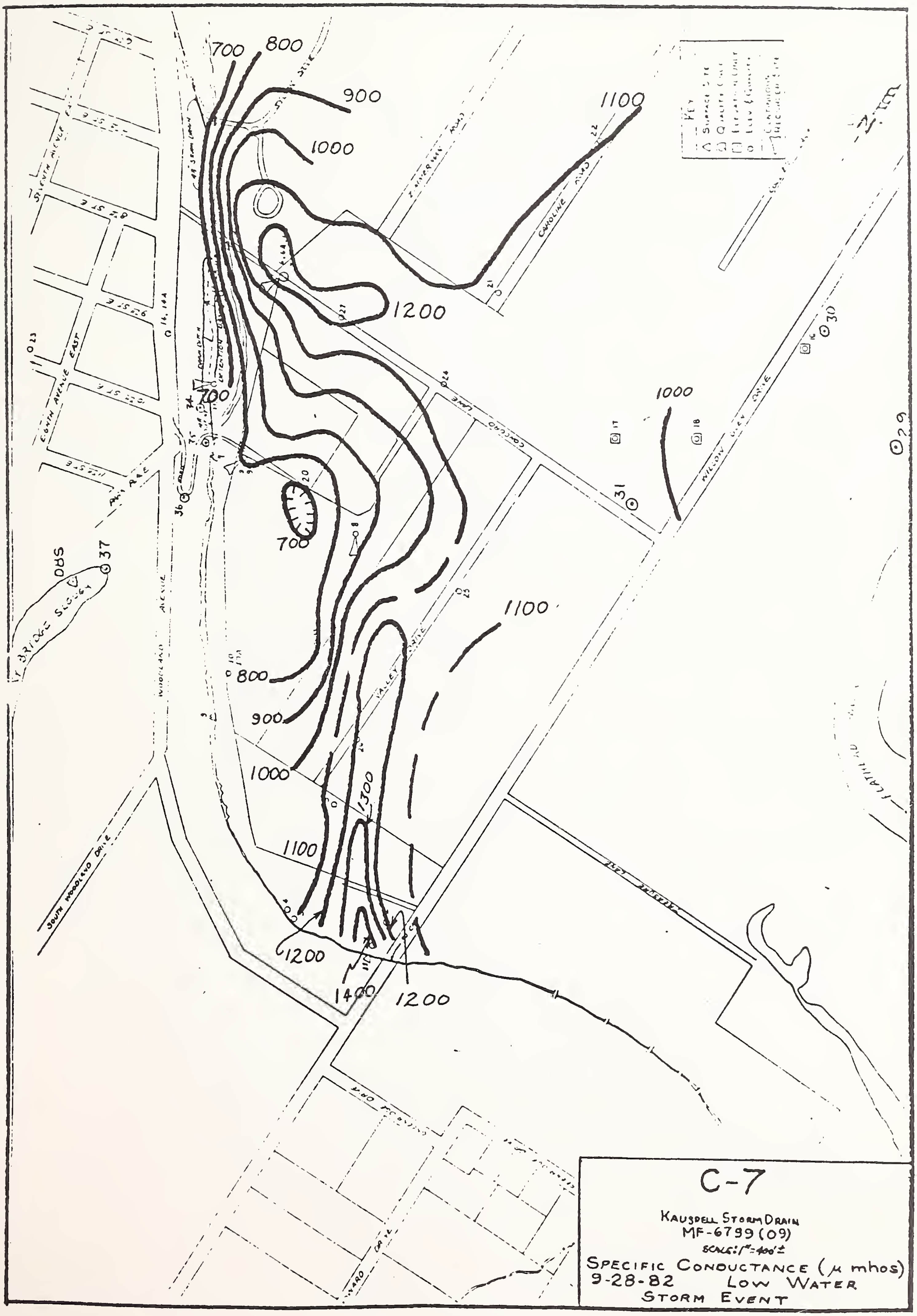
Kausdell Storm Drain
MF-6799 (09)
Scale: 1"=400'±
Specific Conductance (μmho)
2-24-82 Begin Rising Limb



C-5

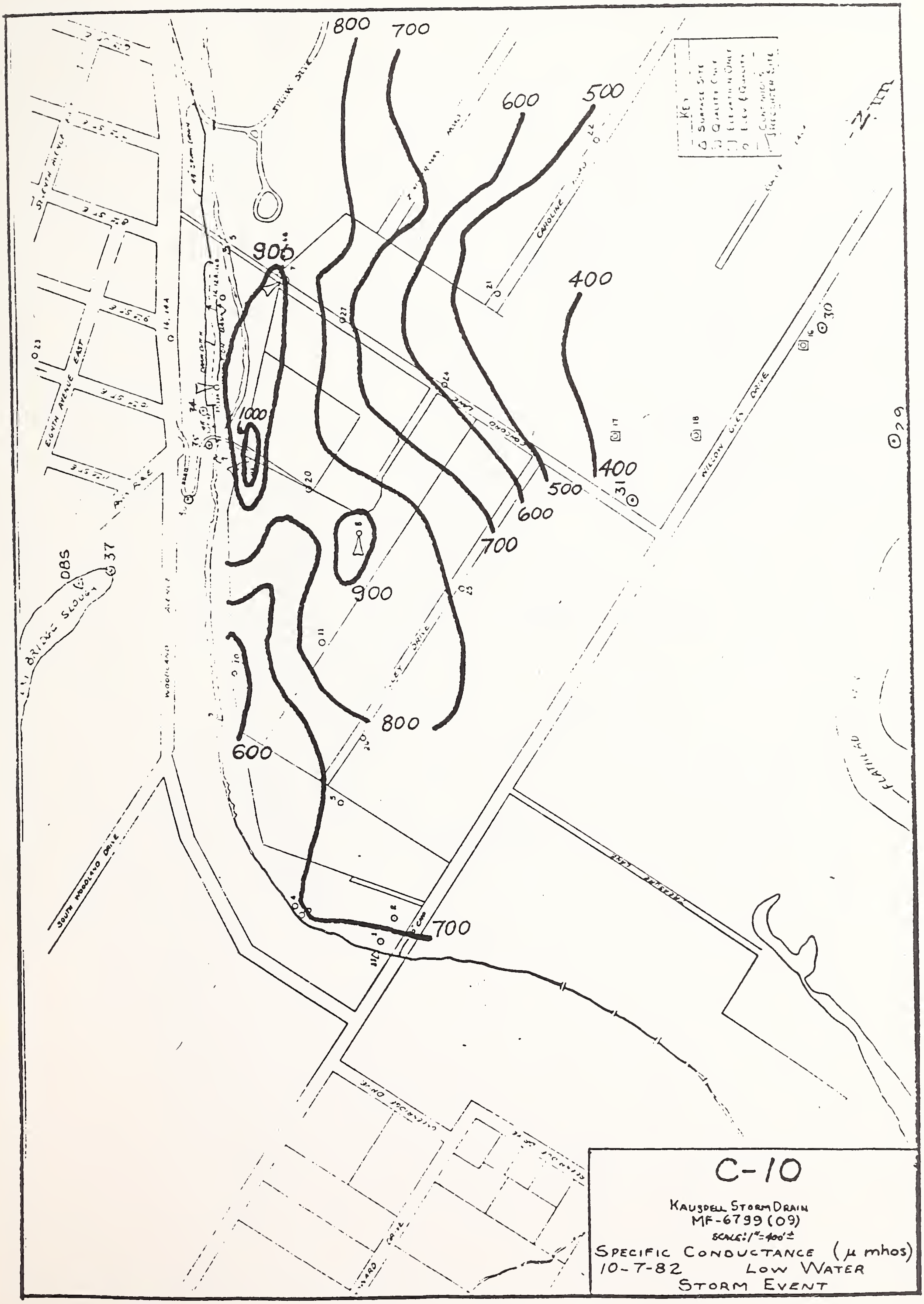
Kausdell Storm Drain
MF-6799 (09)
Scale: 1" = 400' ±

Specific Conductance (μ mhos)
7-13-82 Falling Limb



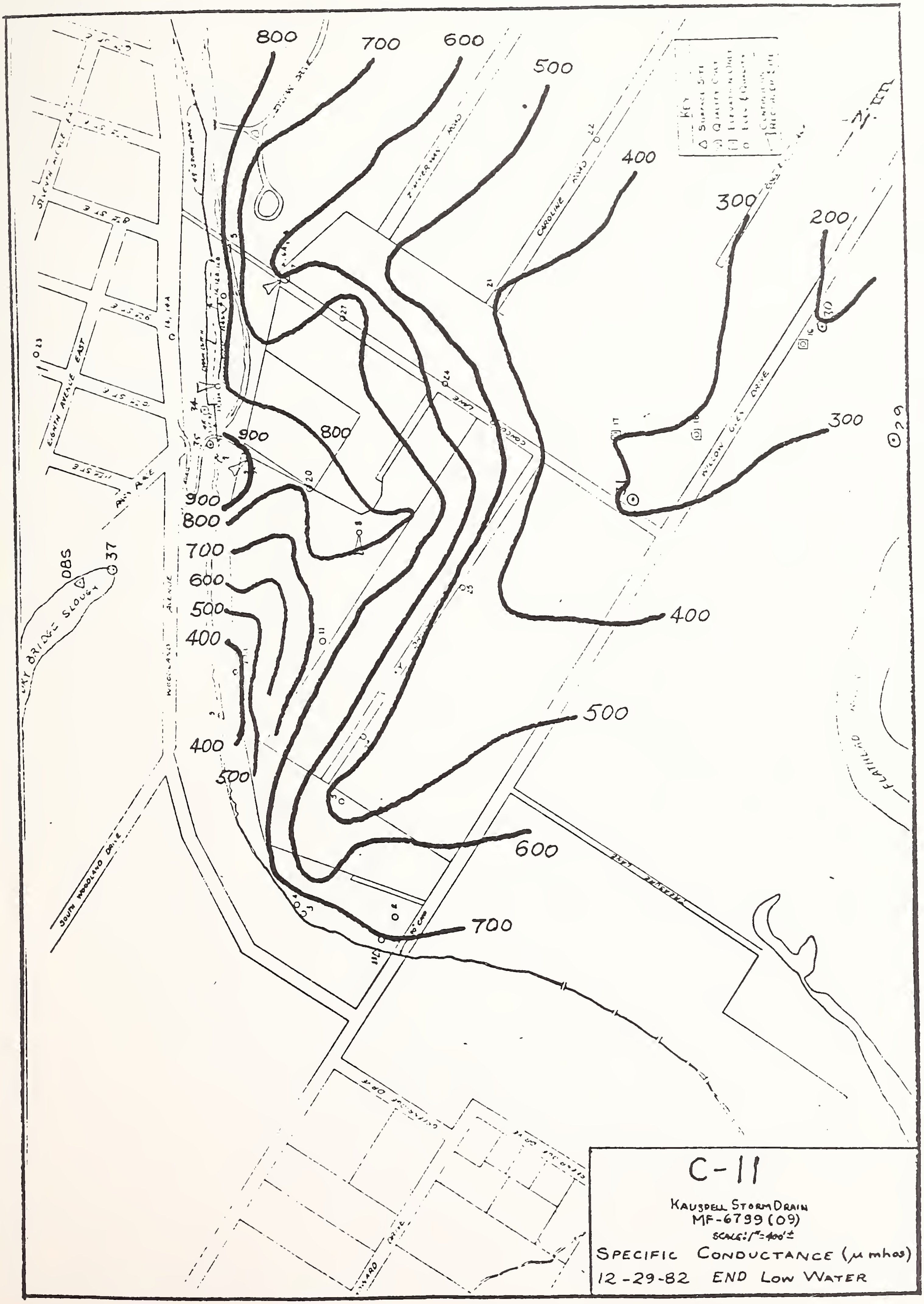
C-7

Kauspell Storm Drain
MF-6799 (09)
Scale: 1" = 400' ±
Specific Conductance (μ mhos)
9-28-82 Low Water
Storm Event



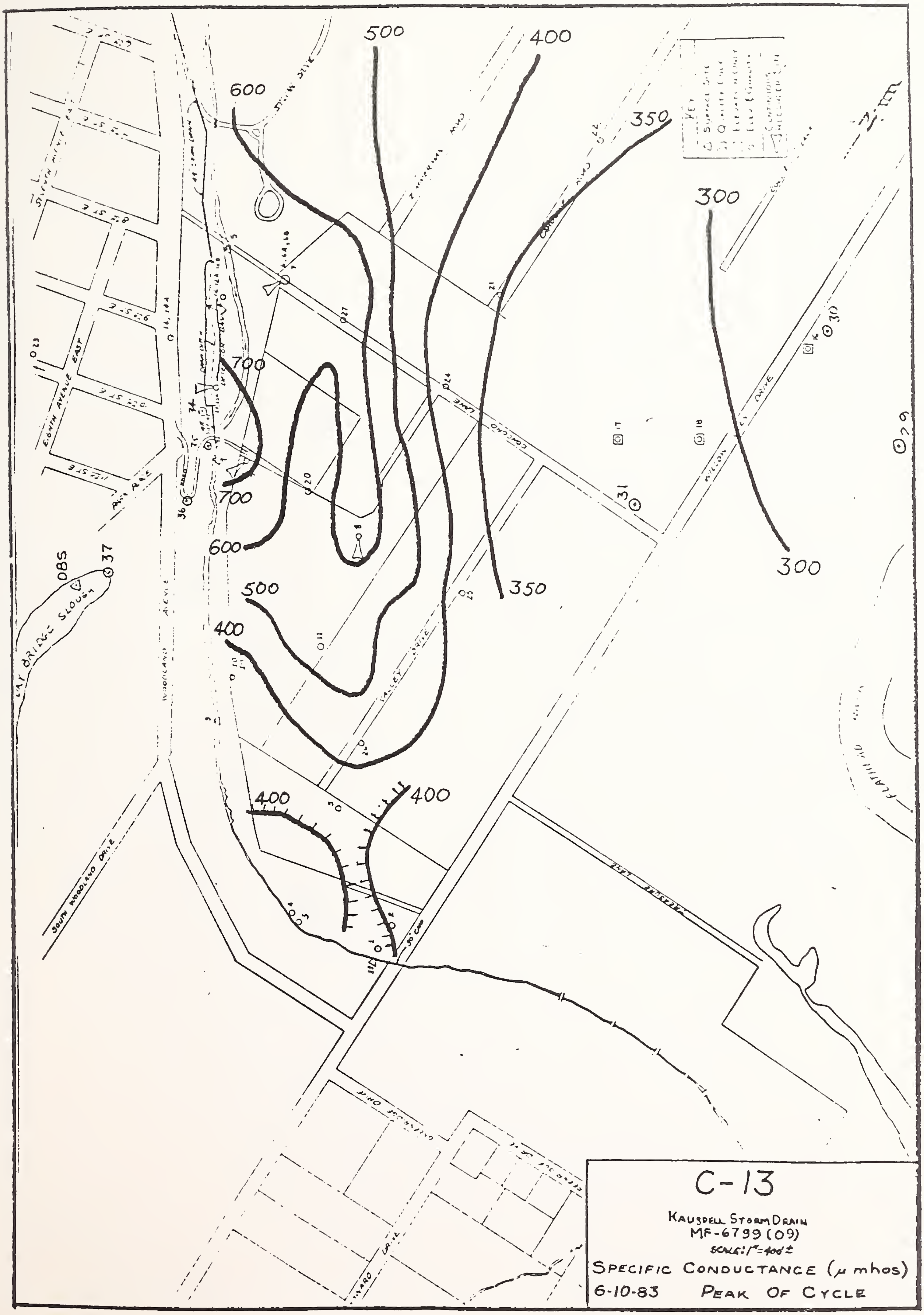
C-10

KALISPELL STORM DRAIN
MF-6799 (09)
SCALE: 1"=400'±
SPECIFIC CONDUCTANCE (μ mhos)
10-7-82 LOW WATER
STORM EVENT



C-11

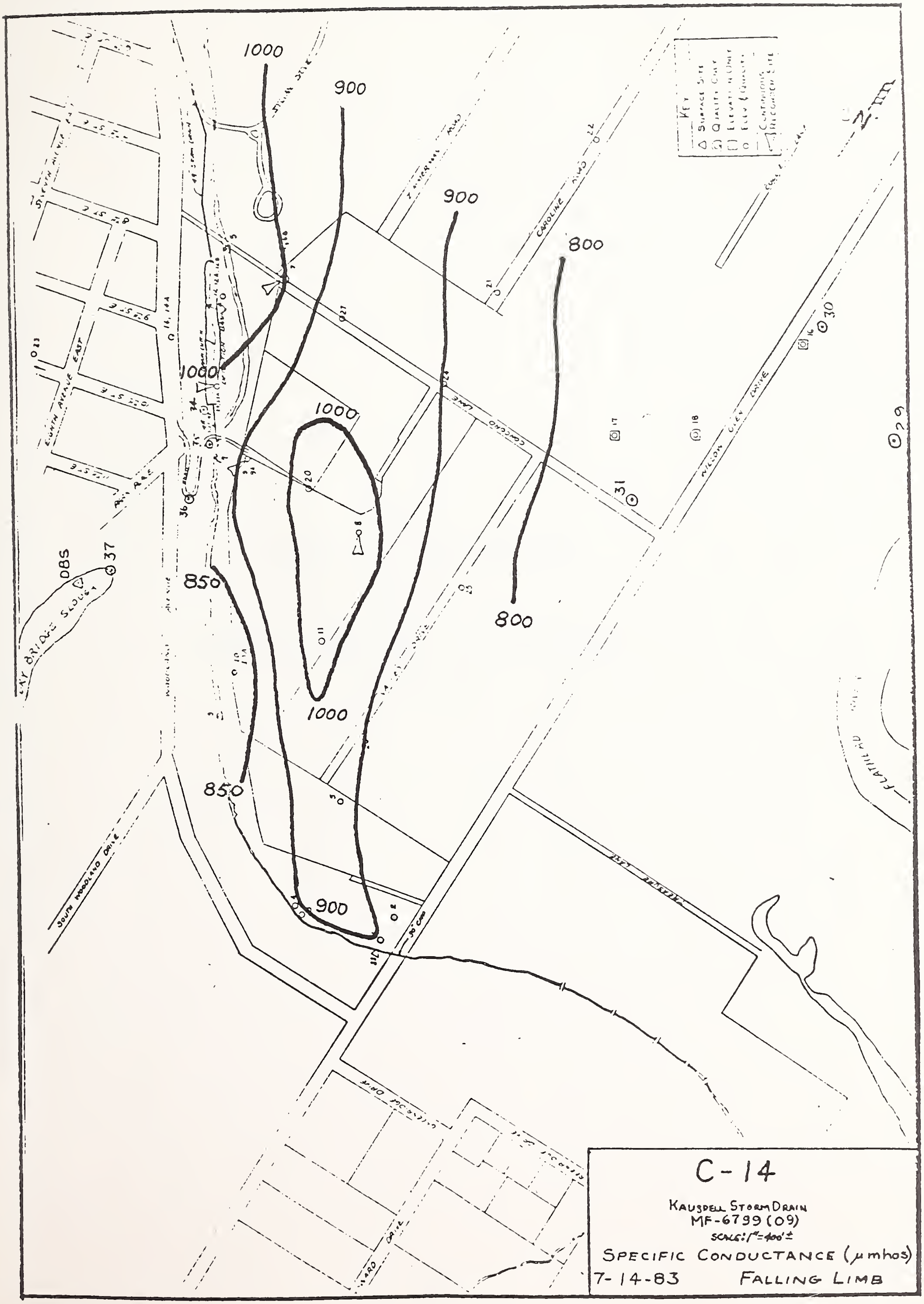
KALISPELL STORM DRAIN
MF-6799 (09)
SCALE: 1" = 400'±
SPECIFIC CONDUCTANCE (µ mhos)
12-29-82 END LOW WATER



C-13

Kalispell Storm Drain
MF-6799 (09)
Scale: 1"=400'±

Specific Conductance (μ mhos)
6-10-83 Peak Of Cycle



C-14

Kauspell Storm Drain
MF-6799 (09)
Scale: 1" = 400' ±

Specific Conductance (μmhos)

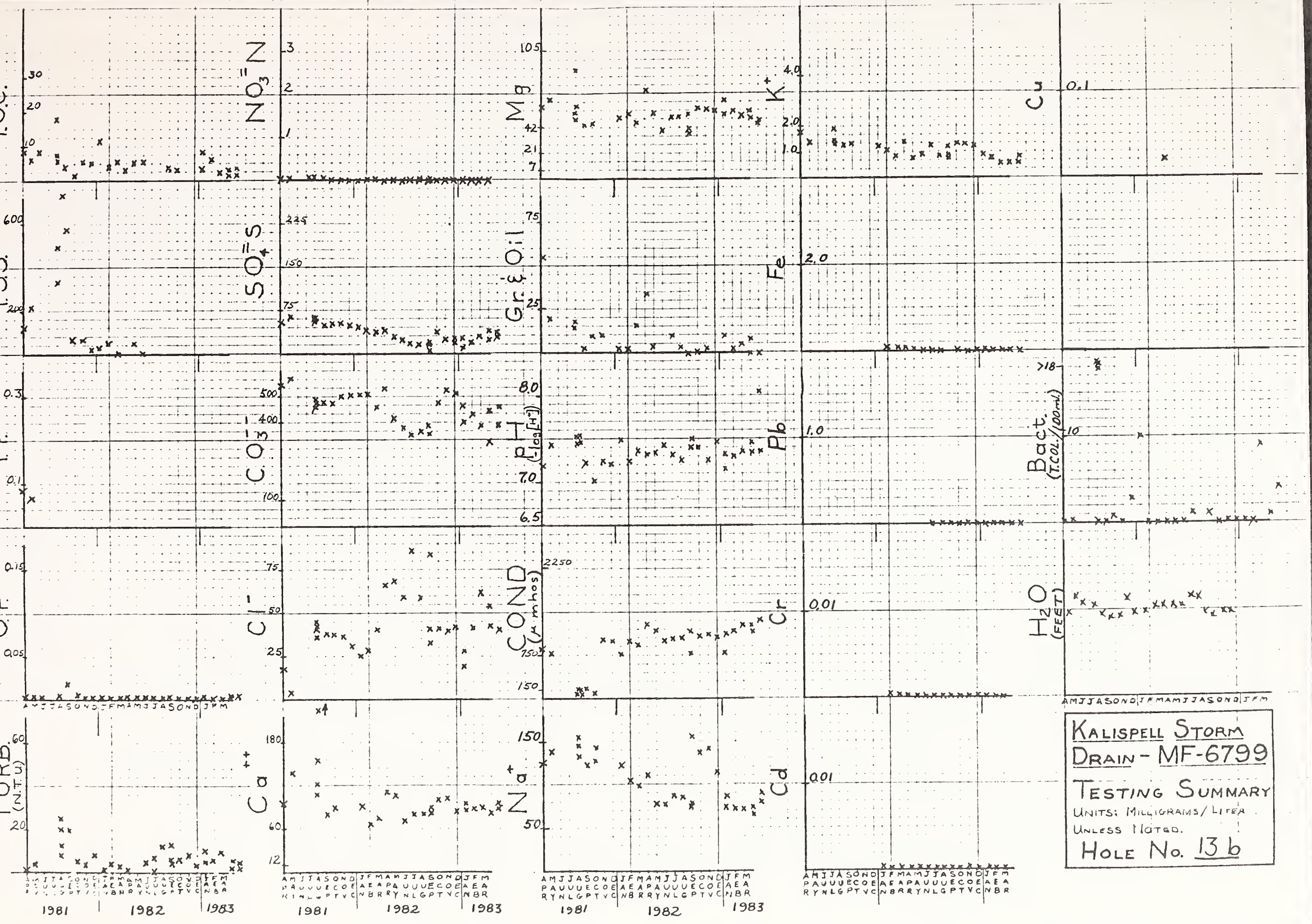
7-14-83 Falling Limb

APPENDIX D

CHEMICAL AND BIOLOGICAL DATA
FOR THE
KALISPELL STORM DRAIN MONITORING PROJECT

MF 6799(09)

JA/sk/2114

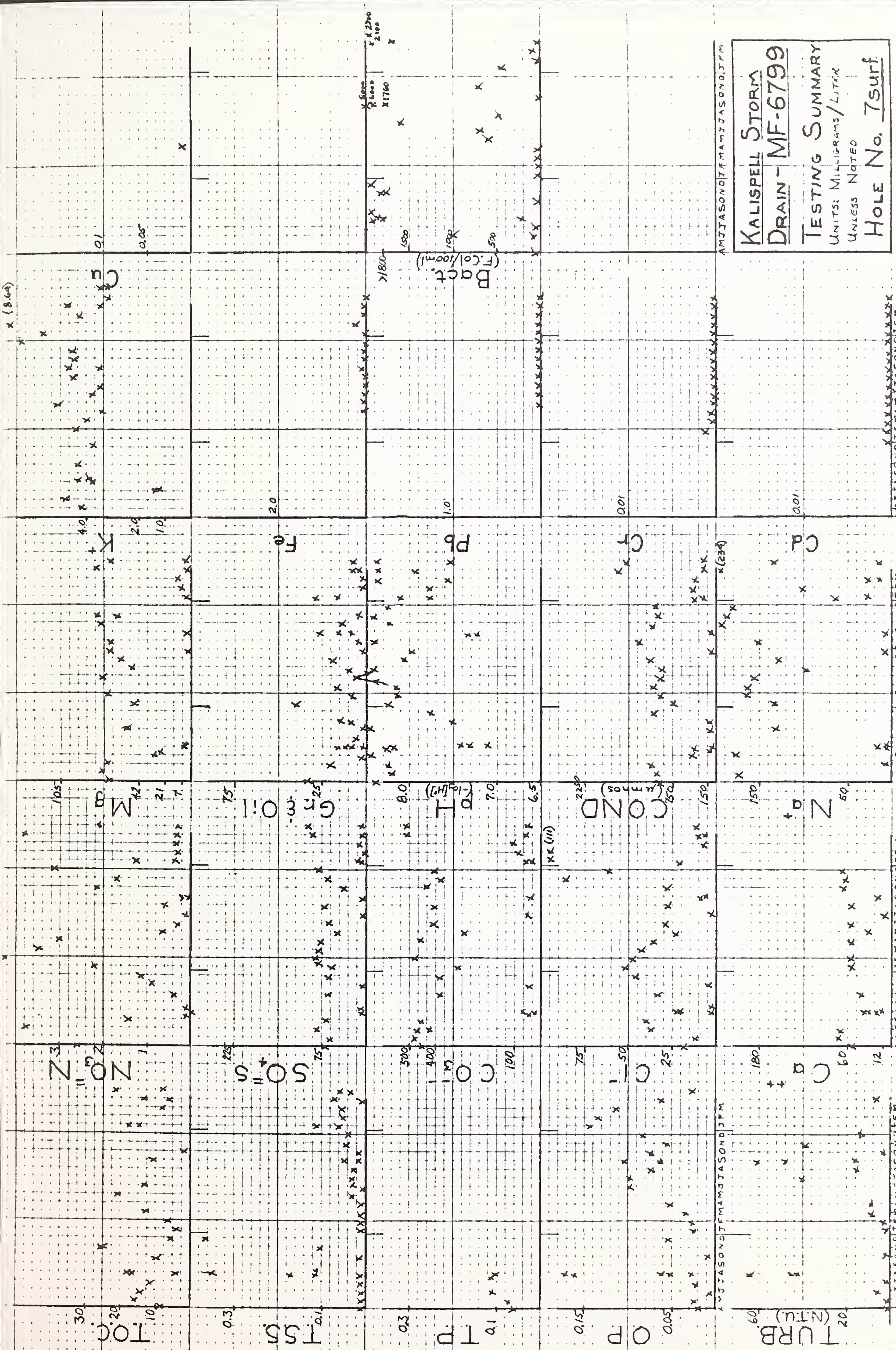


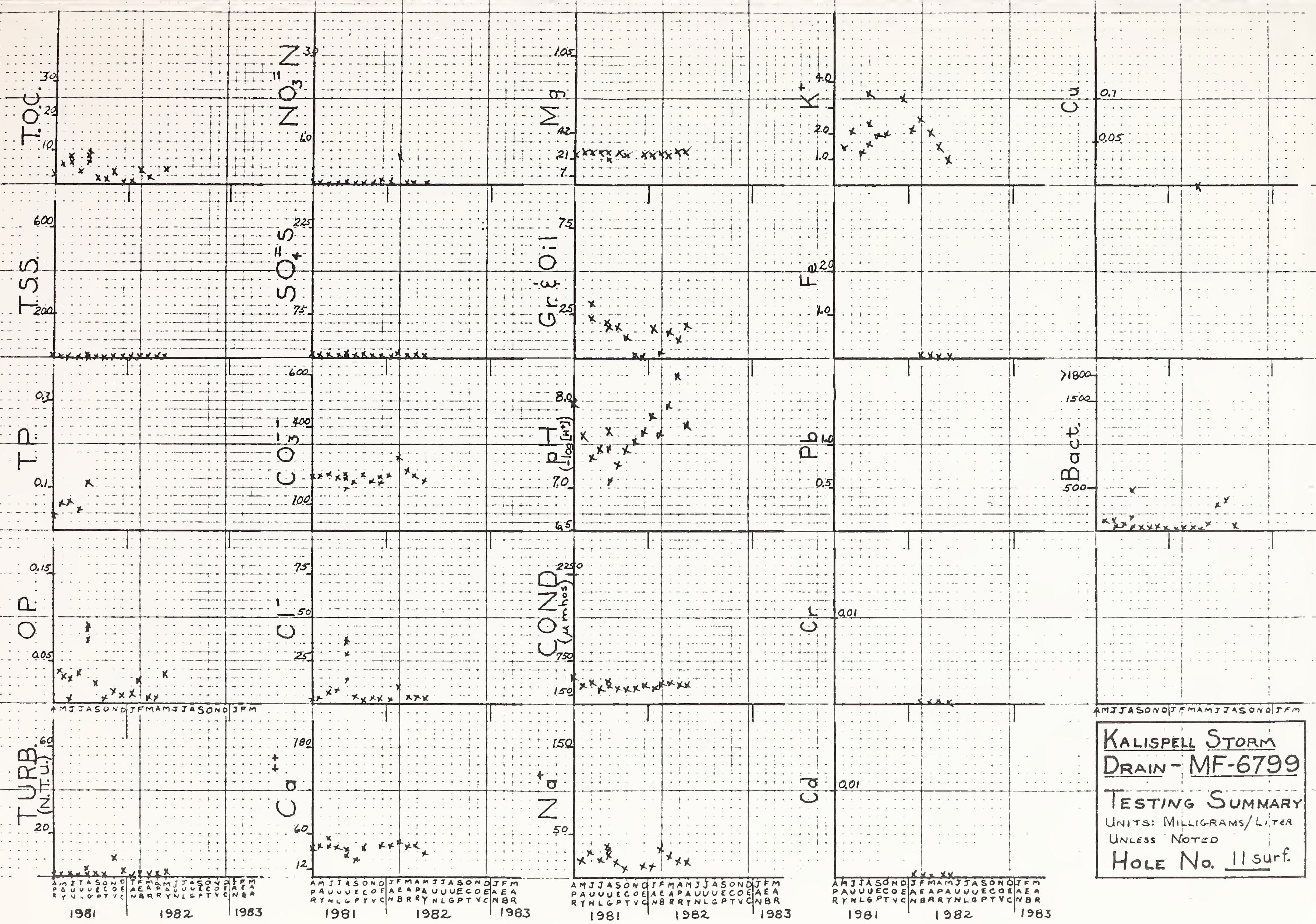
KALISPELL STORM DRAIN - MF-6799

TESTING SUMMARY

UNITS: MILLIGRAMS/LITER UNLESS NOTED.

HOLE No. 13 b


Kalispell Storm Drain - MF-6799
Testing Summary
Units: Milligrams/Liter Unless Noted
Hole No. 7surf
TOC
TSS
TP
OP
TURB (NTU)
NO3 = N
SO4
CO3
Cl
Ca
Mg
Gr. Oil
pH
COND
Na
K
Fe
Pb
Cr
Cd
Cu
Bact. (F.Col/100ml)
AMJJASONDJFM



Kalispell Storm Drain - MF-6799

Testing Summary

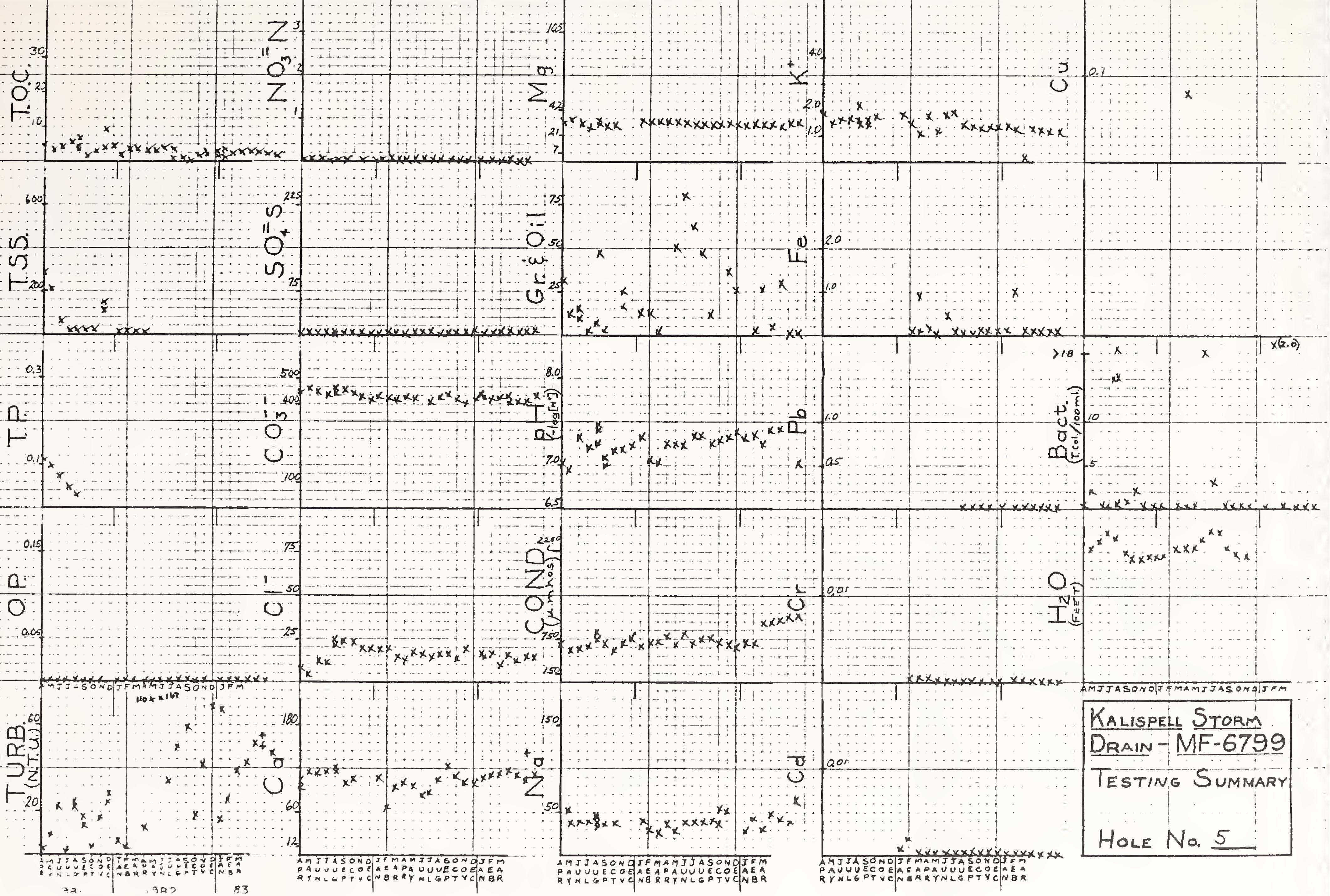
Units: Milligrams/Liter
Unless Noted

Hole No. 11 surf.

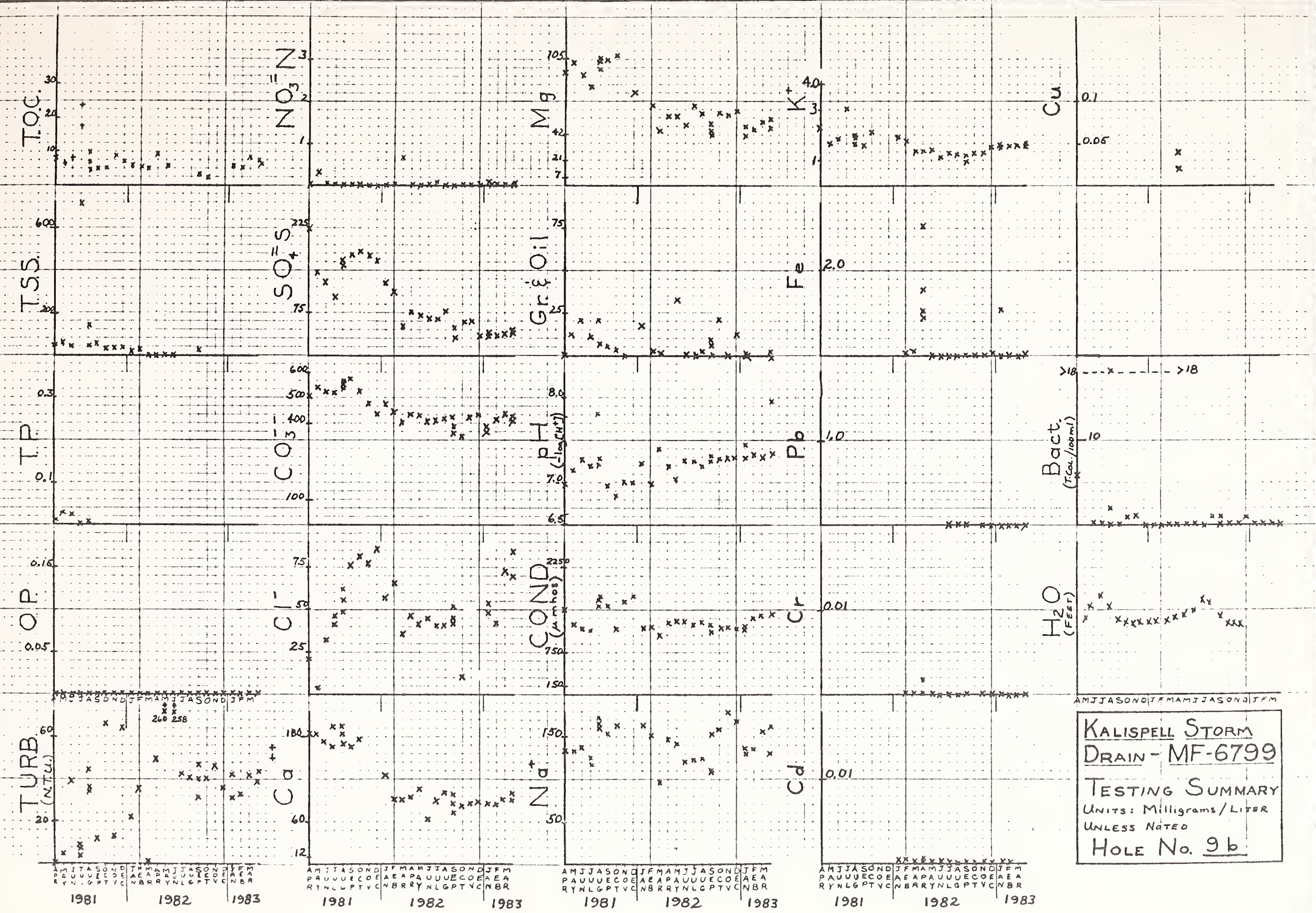
KALISPELL STORM DRAIN - MF-6799

TESTING SUMMARY

HOLE No. 5

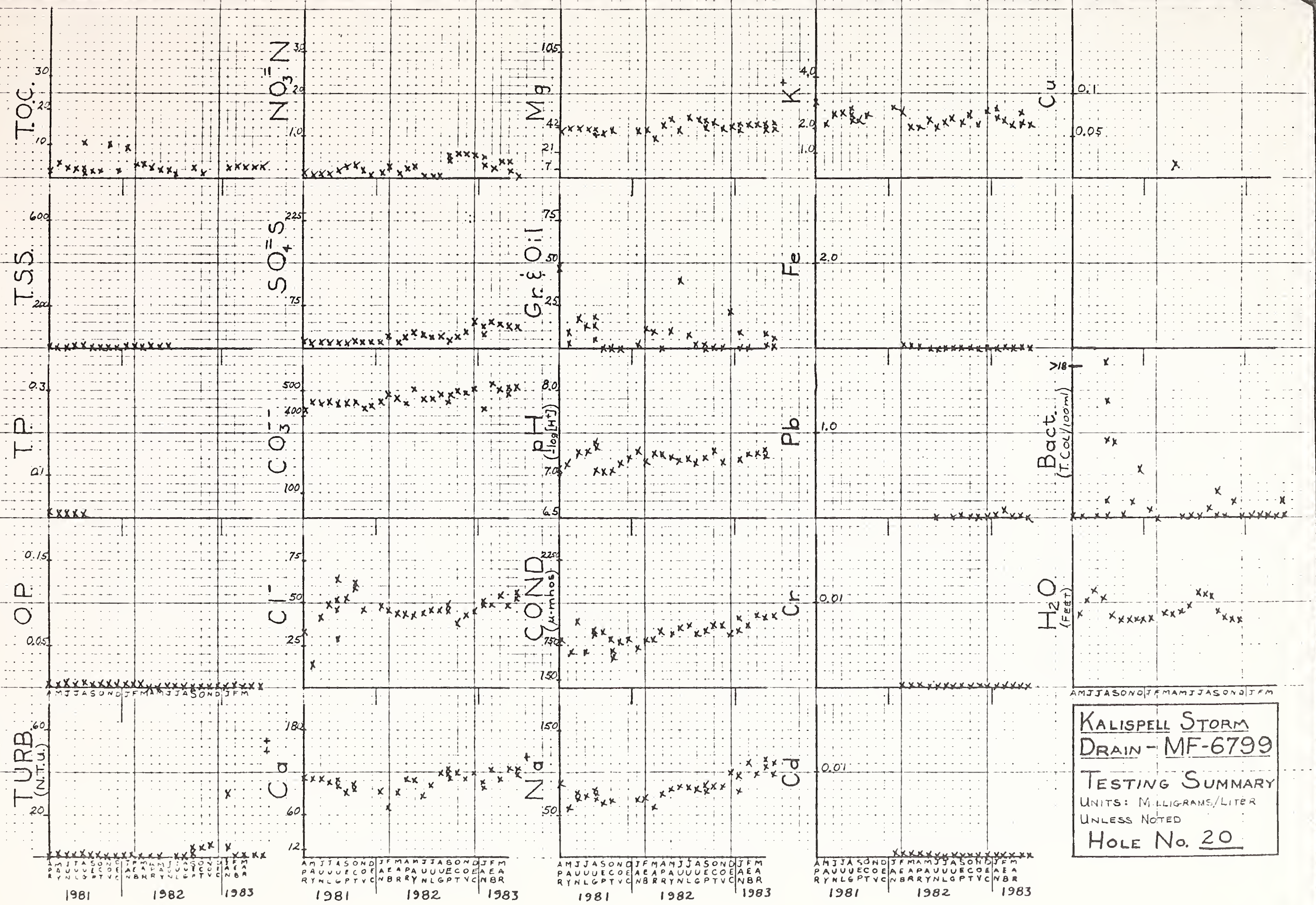


D.4



KALISPELL STORM
DRAIN - MF-6799

TESTING SUMMARY
UNITS: Milligrams/Liter
UNLESS NOTED
HOLE No. 9b



KALISPELL STORM DRAIN - MF-6799

TESTING SUMMARY

UNITS: MILLIGRAMS/LITER UNLESS NOTED

HOLE NO. 20

APPENDIX E

DRILL LOGS

FOR THE

KALISPELL STORM DRAIN MONITORING PROJECT

MF 6799 (09)

JA/sk/2115

Kalispell Water Monitoring
MF 6799(09)

Attached are the drill logs and laboratory test sheets and a well site location map for this project. These wells were installed to monitor groundwater quality and quantity in conjunction with the City of Kalispell's storm drain outfall in this area.

Generally, the wells were drilled in the following manner:

1. An eight inch hollow-stem auger was used to advance the borings to the required depth.

2. Shelby tube and/or split-spoon samples were taken as necessary for soil classification and testing.

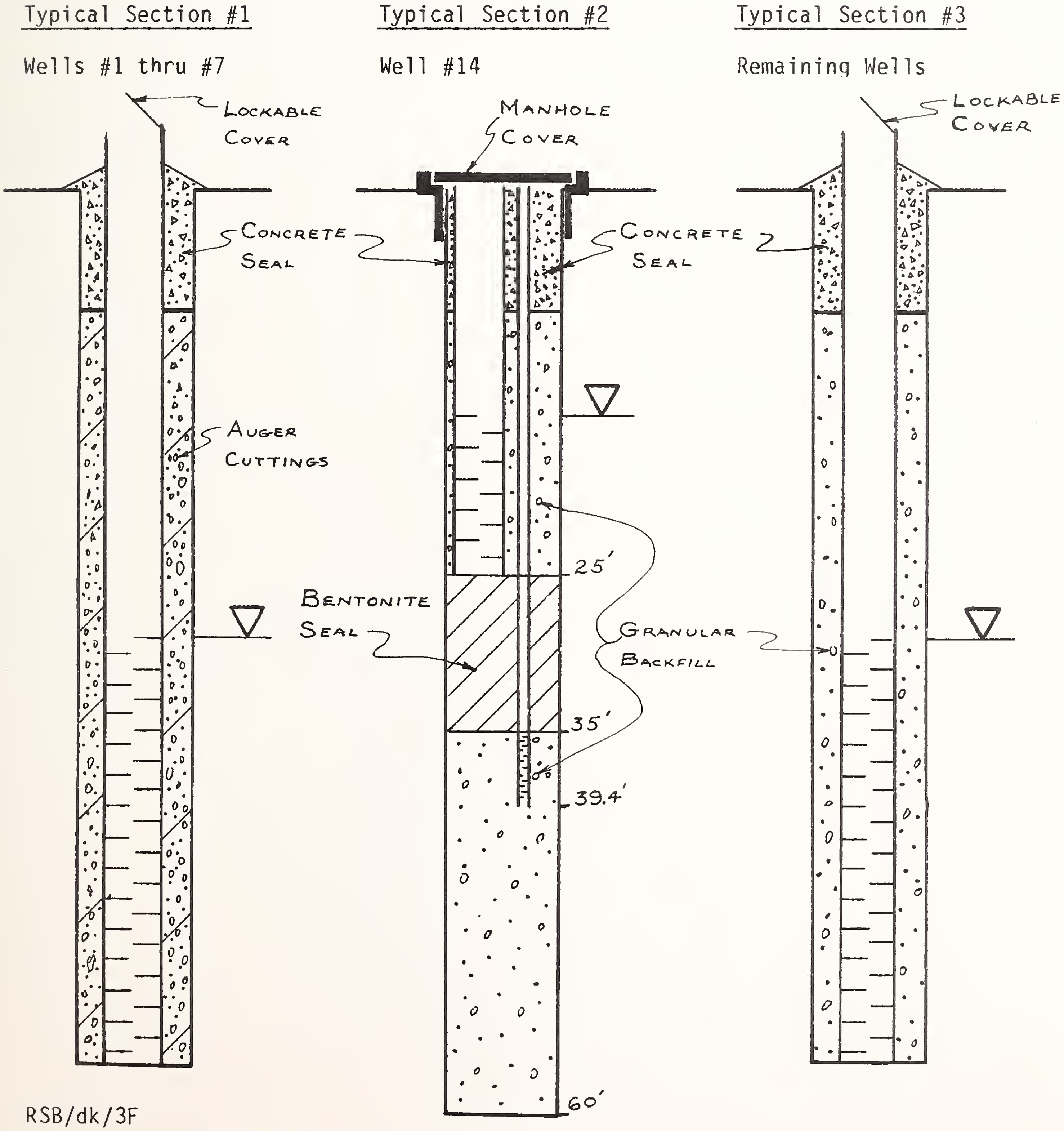
3. The well casing was perforated from the bottom of the casing up through the water zone to the top of the observed water table with saw-slots (less than 1/8 inch wide).

4. Hole numbers 1 through 7 were then backfilled to within about 4 feet of the ground surface with auger cuttings. Due to hydraulic connection difficulties experienced on these first 7 holes, the remainder of the holes were backfilled with granular material to the same depth. A lockable steel collar was then installed and the remainder of the hole backfilled with concrete.

5. At several well sites additional stand pipes were installed to measure water characteristics at a particular elevation, and are designated with sub-letters a, b, or c. These stand pipes were not perforated and are open at the bottom only. One foot of gravel was placed at the bottom at the hole around the stand pipe with the remainder of the

annulus being backfilled with a concrete seal. Lockable covers were installed.

6. Typical sections 1, 2 and 3 show well construction.



Typical Section #1

Wells #1 thru #7

Typical Section #2

Well #14

Typical Section #3

Remaining Wells

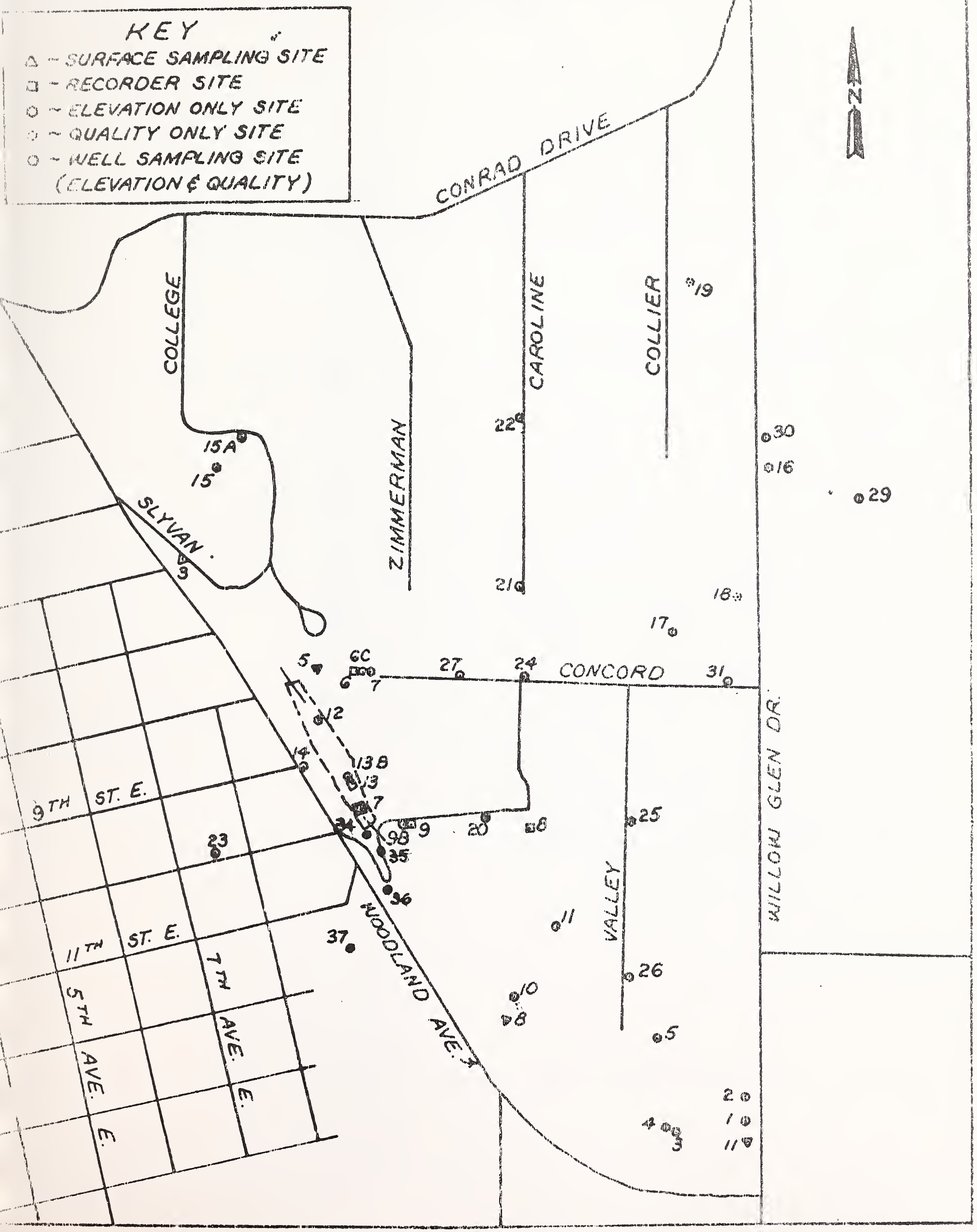
RSB/dk/3F

Wells numbered 16, 17, 18 and 19 are private wells which are being used as additional ground water observation points. Wells 16 and 17 are open irrigation wells and are used for piezometric surface observation only. Wells 18 and 19 are sealed domestic wells and are used for Water Quality Monitoring only.

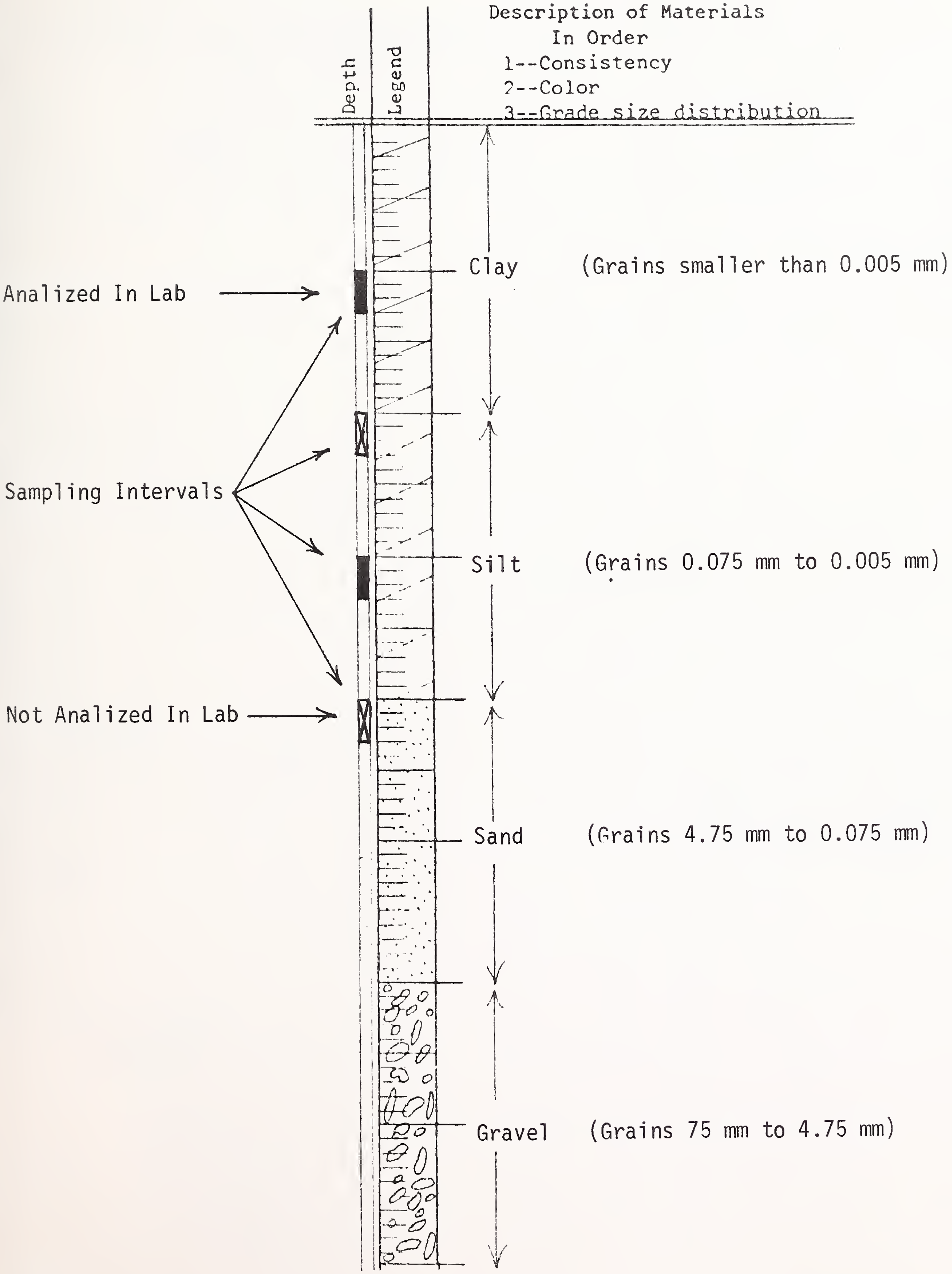
We do not have drill logs for wells 17, 18, or 19, but it is known that they are shallow wells with total depths of approximately 30 feet or less. We do have the drill log for well 16. It has a total depth of 24 feet.

RSB/dk/4P

KALISPELL CITYWIDE WATER MONITORING



DRILL LOG LEGEND


Depth
Legend
Description of Materials
In Order
1--Consistency
2--Color
3--Grade size distribution
Analized In Lab
Sampling Intervals
Not Analized In Lab
Clay
(Grains smaller than 0.005 mm)
Silt
(Grains 0.075 mm to 0.005 mm)
Sand
(Grains 4.75 mm to 0.075 mm)
Gravel
(Grains 75 mm to 4.75 mm)

DK:ka

Lab. Form 30
Revised 09-22-78

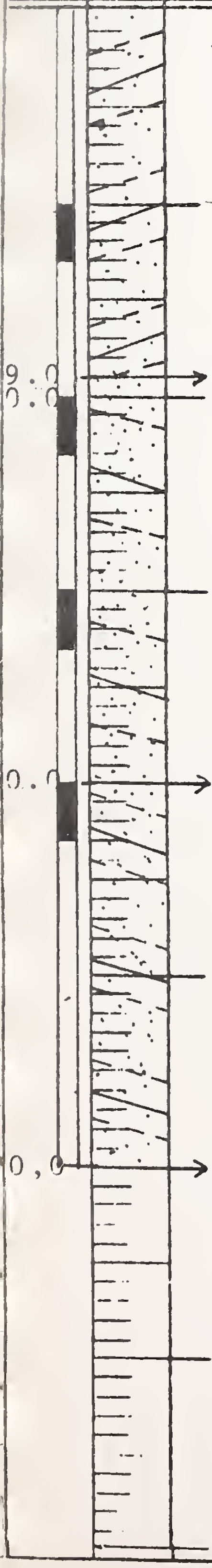
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-129-80 Proj. No. MF 6799 (7) Hole No. 1 Date Taken 12/4/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Lot T-6EA Daugharty Driller Gorr, Fuller, Brigman

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Light brown clayey sandy silt
9.0 – 10.0		9.0 10.0 Grey medium grained clayey silty sand
20.0		20.0 Grey sandy clayey silt
30.0		T.D. 30.0 Bottom of hole in same material



Collar Elev.	2901.79
Depth of Hole	30.0'
Elev. of Ground Water	2896.4
Wt. of Hammer	-
Average Fall of Hammer	-

2" Split Spoon Penetration Test - 140# Hammer

~~Blows~~	Pene.	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	1.5	10.0	11.5	"
/ /	1.5	15.0	16.5	"
/ /	1.5	20.0	21.5	"
/ /	1.5	23.5	25.0	"
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				

30.5' augers 8"

Auger core plugged w/sand @ 25'

22.3' 4" PVC casing perforated @ 8" interval from 22.3' to 5.0'
Installed 6" steel casing protection collar W/ lockable cover.

Lab. Form 30
Revised 09-22-78

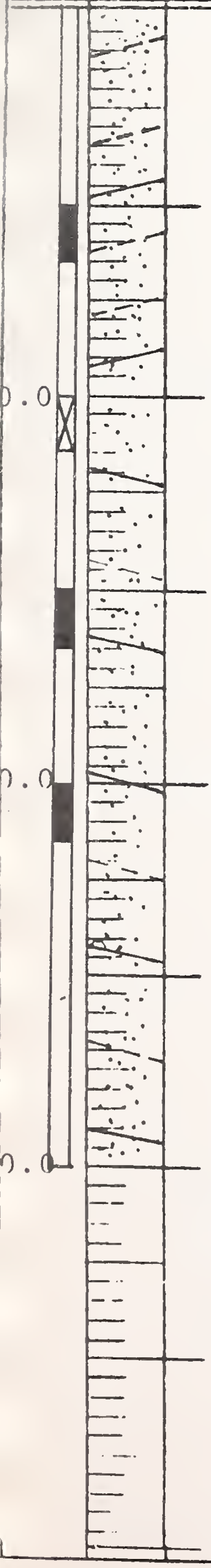
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-130-80 Proj. No. MF 6799 (7) Hole No. 2 Date Taken 12/4/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Lot T-6EA Daugharty Driller Gorr, Fuller, Brigman

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Grey medium grained clayey silty sand
		T.D. 30.0 Bottom of hole in same material



Collar Elev.	2905.06
Depth of Hole	30.0'
Elev. of Ground Water	2895.41
Wt. of Hammer	-
Average Fall of Hammer	-

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	1.5	10.0	11.5	"
/ /	1.5	15.0	16.5	"
/ /	1.5	20.0	21.5	"
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				

30.5' Augers 8"

Auger core plugged w/sand @ 25.0'

23.6' 4" PVC Casing perforated @ 8" intervals from 23.6' to 10.0'

Installed 6" steel casing protective collar w/ lockable cover

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

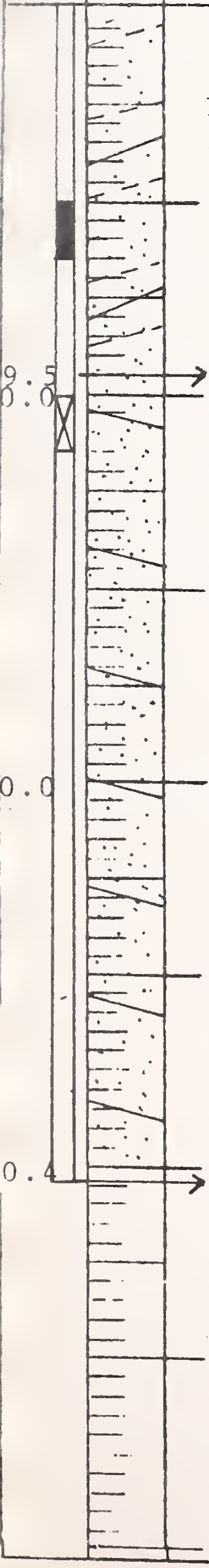
Core Log No. 6-131-80 Proj. No. MF 6799 (7) Hole No. 3 Date Taken 12/10/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Lot T-6DB · Maxey Driller Gorr, Fuller, Brigman

Collar Elev. 2904.1
Depth of Hole 30.0'
Elev. of Ground Water 2896.03
Wt. of Hammer -
Average Fall of Hammer -

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Light brown clayey sandy silt
		9.5
		10.0
		Grey medium grained clayey sand
		20.0
		T.D. 30.0 Bottom of hole in same material



2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	1.5	10.0	11.5	"
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				

15.5' Auger 8"

Auger core plugged w/sand @ 15.6'

29.5' 4" PVC casing Perforated @ 8" intervals from 29.5' to 8.0'
Installed 6" steel casing protective collar w/ lockable cover

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-132-80 **Proj. No.** MF 6799 (7) **Hole No.** 4 **Date Taken** 12/10/89

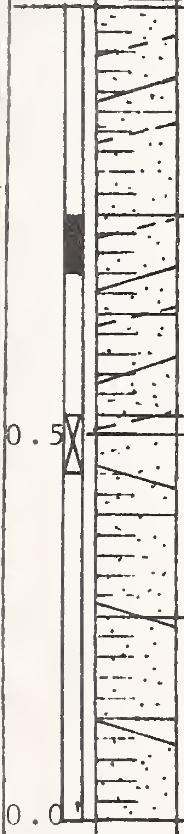
Proj. Name Kalispell Storm Drain System **Exploration Drilling for** Water Monitoring

Location Lot T-6DBA Maxey **Driller** Gorr, Fuller, Brigman

Collar Elev. 2904.12
Depth of Hole 20.0'
Elev. of Ground Water 2896.59
Wt. of Hammer -
Average Fall of Hammer

Depth | **Legend** | **Description of Materials In Order**
1--Consistency
2--Color
3--Grade size distribution

Blow Counts | **Pene-tration**



Light brown clayey silty sand

→10.5

Grey medium grained clayey sand

→T.D. 20.0

Bottom of hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5'	5.0	6.5	Shelby
/ /	1.5'	10.0	11.5	"
/ /	1.5'	11.5	13.0	No recovery
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				

20.4' NX casing

20.0' 1" PVC pipe perforated @ 8" intervals from 20.0' to 8.0'
Installed 1¼" steel protective collar w/lockable cover

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

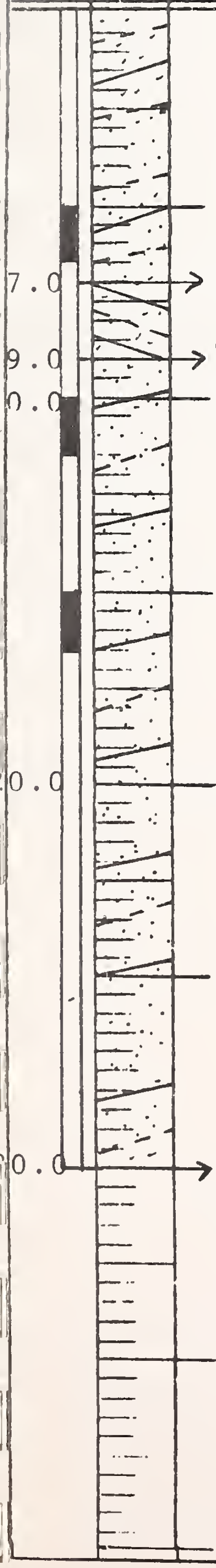
Core Log No. 6-133-80 Proj. No. MF 6799 (7) Hole No. 5 Date Taken 12/10/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Tract 3B Trewick Driller Gorr, Fuller, Brigman

Collar Elev. 2898.04
Depth of Hole 30.0
Elev. of Ground Water 2895.37
Wt. of Hammer -
Average Fall of Hammer -

Depth | Legend | Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution | Blow Counts | Pene-tration



Tan sandy clayey silt

7.0
Light grey sandy silty clay

9.0

10.0
Grey medium grained silty clayey sand

20.0

T.D. 30.0
Bottom of hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	1.5	10.0	11.5	"
/ /	1.5	15.0	16.5	"

15.5' Auger 8"

Auger core plugged w/sand @ 15.5'

30.0' 4" PVC casing perforated @ 8" intervals from 30.0' to 3.0'
Pushed casing from 15' to 28.5' and washed out

Installed 6" steel casing protective collar w/ lockable cover

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

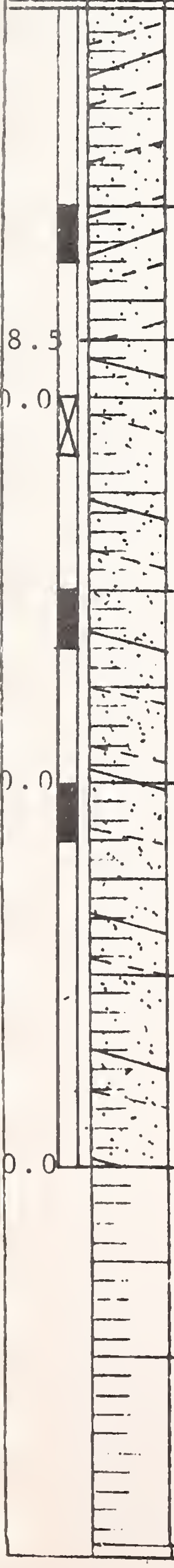
Core Log No. 6-134-80 Proj. No. MF 6799 (7) Hole No. 6 Date Taken 12/11/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location West End of Concord Lane, City Driller Gorr, Fuller, Brigman

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration

Collar Elev. 2904.7
Depth of Hole 30.0
Elev. of Ground Water 2896.32
Wt. of Hammer -
Average Fall of Hammer -



Tan clayey sandy silt

8.5

10.0

Grey medium grained clayey silty sand

20.0

T.D. 30.0

Bottom of hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	1.5	10.0	11.5	"
/ /	1.5	15.0	16.5	"
/ /	1.5	20.0	21.5	"
/ /				
/ /				
/ /				
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/ /				
/ /				
/ /				
/ /				

20.5' Augers 8"
Auger core plugged w/sand @ 20.0'
30.0' 4" PVC Casing perforated @ 8" intervals from 30.0' to 8.0'
Pushed casing from 20.0' to 28.5' and washed out
installed 6" steel casing protective collar w/lockable cover

Hole No.6a Drilled at above location 15' Auger - 16.0' PVC not slotted placed 1'gravel at bottom of hole then filled remainder with concrete.
Hole No. 6b drilled at above location. 10.0' 8" Augers 11.0' 1" PVC not perforated Placed 1.0' gravel at bottom of hole then backfilled remainder of hole with concrete

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-28-81 **Proj. No.** MF 6799(7) Hole No. 6c Date Taken 4/7/81

Proj. Name Kalispell Storm Drain System **Exploration Drilling for** Water Monitoring

Location West End of Concord Lane **Driller** Gorr, Fuller, Brigman

Depth	Legend	**Description of Materials In Order** 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration
		Brown and grey silt		
5.0		→ 5.0		
		Grey silt		
15.0		→ T.D. 15.0 same material		

Collar Elev. 2901.91
Depth of Hole 15.0
Elev. of Ground Water 2895.52
Wt. of Hammer -
Average Fall of Hammer -

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				
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/ /				
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/ /				

15.5' Auger 8"

20.0' 4" PVC pipe slotted at 6" intervals from 20.0' to 6.5'

No samples taken

Were unable to advance augers past 15.5" so PVC pipe was pushed to 20.0' then washed out

6" lockable casing cover installed.

Lab. Form 30
Revised 09-22-78

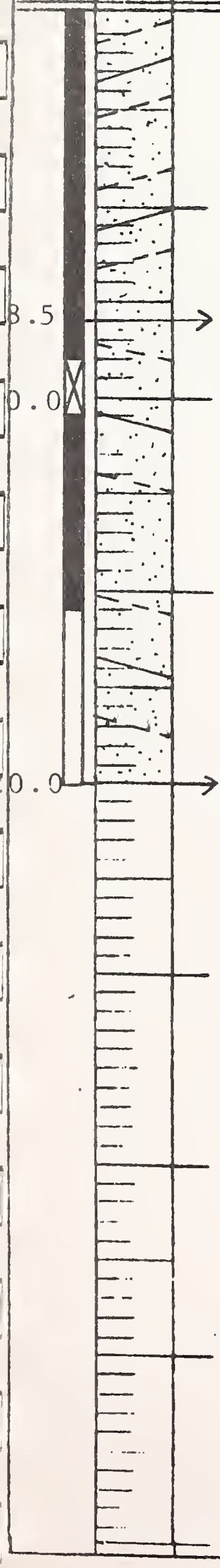
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-135-80 Proj. No. MF 6799(7) Hole No. 7 Date Taken 12/11/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location West End of Concord Lane, City Driller Gorr, Fuller, Brigman

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Grey clayey sandy silt
8.5		→ 8.5
0.0		10.0
		Grey medium grained clayey silty sand
0.0		→ T.D. 20.0
		Bottom of hole in same material



Blow Counts | Pene- tration

Collar Elev. 2901.52
Depth of Hole 20.4
Elev. of Ground Water 2896.35
Wt. of Hammer
Average Fall of Hammer

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	0.0	1.5	Shelby
/ /	"	1.5	3.0	"
/ /	"	3.0	4.5	"
/ /	"	4.5	6.0	"
/ /	"	6.0	7.5	"
/ /	"	7.5	9.0	"
/ /	"	9.0	10.5	"
/ /	"	10.5	12.5	"
/ /	"	12.5	14.0	"
/ /	"	14.0	15.5	"
/ /	"	15.5	17.0	No Recovery
/ /				
/ /				
/ /				
/ /				
/ /				

20.4' NX Casing

20.0' 1" PVC Pipe perforated @ 6" intervals from 20.0' to 5.0'

Installed 1¼" steel protective collar w/lockable cover

Lab. Form 30
Revised 09-22-78

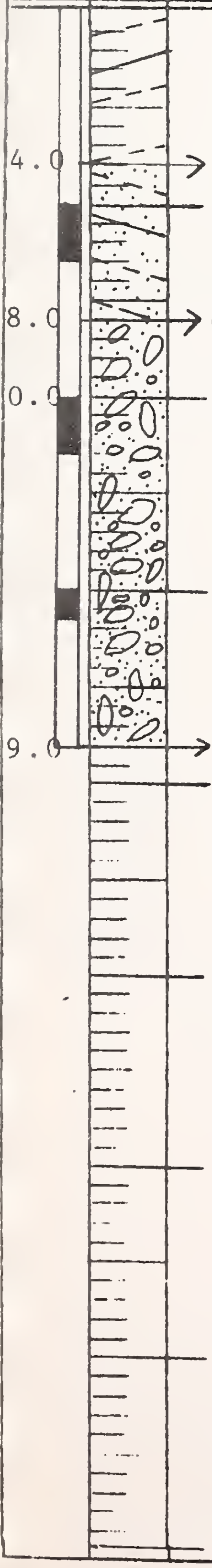
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-136-80 Proj. No. MF 6799 (7) Hole No. 8 Date Taken 12/15/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location North Central Portion of 3C Driller Gorr, Fuller, Brigman Johnson

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Brown clayey silt
4.0		4.0
		Brown clayey silty sand
8.0		8.0
0.0		10.0
		Brown sandy gravel
9.0		T.D. 19.0
		Bottom of hole in same material



Collar Elev.	2903.61
Depth of Hole	19.0'
Elev. of Ground Water	2895.38
Wt. of Hammer	-
Average Fall of Hammer	-

2" Split Spoon Penetration Test - 140# Hammer

Blow Counts	Penetration			
Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
/ /	.7	15.0	15.7	"
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/ /				

20.4' Augers 8"

19.0' 4" PVC casing
perforated @ 8" intervals
from 19,0' to 8.3'

Installed 6" steel casing
protective collar w/
lockable cover

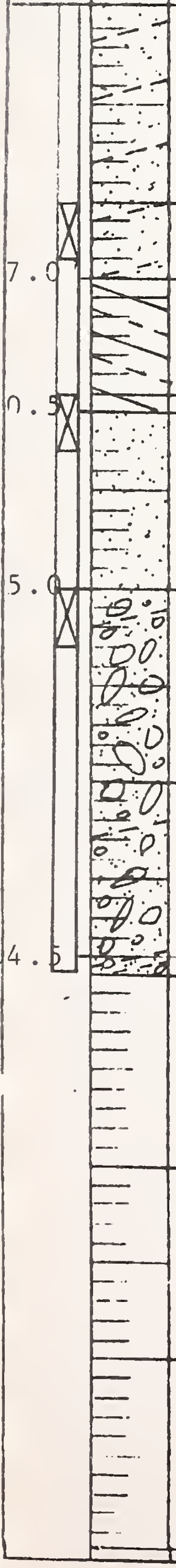
Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-137-80 Proj. No. MF 6799 (7) Hole No. 9 Date Taken 12/16/80
Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring
Location NW Portion of 3C Johnson Driller Gore, Fuller, Brigman

Collar Elev. 2903.78
Depth of Hole 25.0'
Elev. of Ground Water 2895.57
Wt. of Hammer 140 lb.
Average Fall of Hammer 30"

Depth | Legend | Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution | Blow Counts | Pene-tration



Light brown sandy silt

→ 7.0
Brown silty clay

→ 10.5
Grey sand

→ 15.0
Dense brown sandy gravel

→ 24.5
Silty sandy gravel

→ T.D. 25.0
Bottom of hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
11/21/27	"	15.0	16.5	Split Spoon
/ /				
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/ /				
/ /				
/ /				
/ /				

25.5' Augers 8"

21.0' 4" PVC casing perforated @ 8" intervals from 21.0' to 8.5' installed 6" steel casing protective collar w/ lockable cover

Hole No.9a Drilled at above location 10.0' 8" Augers 11.0' unslotted PVC 1" installed. 1' gravel backfill. Remainder backfilled with concrete

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-29-81 Proj. No. MF 6799 (7) Hole No. 9b Date Taken 4/7/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location N.W. Portion of TR 3C Johnson Driller Gorr, Fuller, Brigman

Collar Elev. 2903.89
Depth of Hole 20.0'
Elev. of Ground Water 2894.93
Wt. of Hammer
Average Fall of Hammer

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Brown silt
10.0		→ 10.0
		Grey silty clay
15.0		→ 15.0
		Brown sandy silt
20.0		→ T.D. 20.0
		Same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
/ /				
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20.5' Augers 8"

20.0' 4" PVC pipe slotted at 6" intervals from 20.0' to 9.0'

No sample taken

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

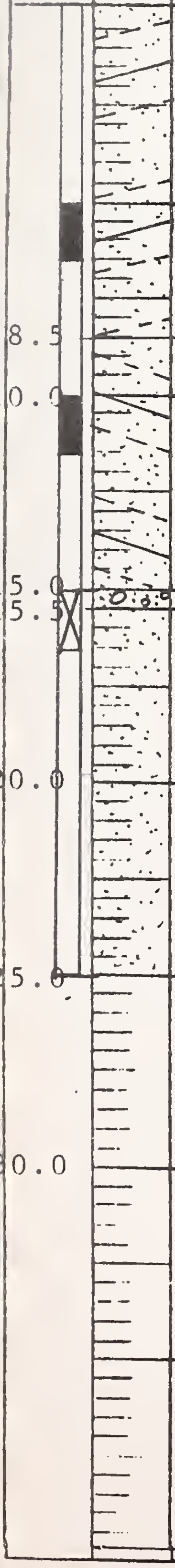
Core Log No. 6-138-80 Proj. No. MF 6799 (7) Hole No. 10 Date Taken 12/16/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location South Portion of 3C Johnson Driller Gorr, Fuller, Brigman

Collar Elev. 2903.67
Depth of Hole 25.0'
Elev. of Ground Water 2896.05
Wt. of Hammer 140 lb.
Average Fall of Hammer 30"

Depth | **Legend** | **Description of Materials In Order**
1--Consistency
2--Color
3--Grade size distribution



Light brown clayey sandy silt

8.5

10.0
Grey sandy clayey silt

15.0
Medium dense brown sandy gravel

15.5

20.0
Grey sand

T.D. 25.0
Bottom of hole in same material

Blow Counts | **Pene-tration**

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
12/10/12		15.0	16.5	Split Spoon
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/ /				

25.4' Augers 8"

20.0' 4" PVC casing perforated @ 3" intervals from 20.0' to 7.5' installed 6" steel casing protective collar w/ lockable cover

Hole No. 10a
Drilled at above location
No log recorded
Depth 10.5'

Lab. Form 30
Revised 09-22-78

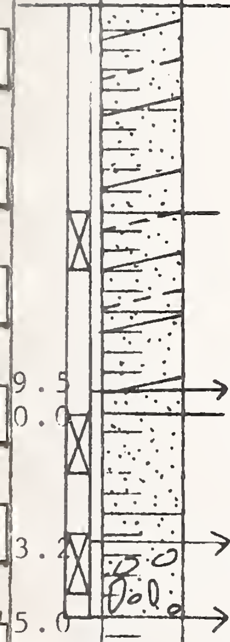
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-139-80 Proj. No. MF 6799 (7) Hole No. 11 Date Taken 12/16/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location E. Central Portion of 3C Johnson Driller Gorr, Fuller, Brigman

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration



Very loose light brown silty sandy clay

→ 9.5
10.0
Very loose grey sand

→13.2
Dense sandy gravel
→T.D. 15.0

Bottom of hole in same material

Collar Elev. 2901.56
Depth of Hole 15.0'
Elev. of Ground Water 2895.33
Wt. of Hammer 140 lb
Average Fall of Hammer 30"

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
1/1/2	1.5	5.0	6.5	Split Spoon
1/1/1	"	10.0	11.5	" "
9/26/50	"	13.0	14.5	" "
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/ /				

15.5' Augers 8"

15.5' 4" PVC casing perforated @ 4" intervals from 15.5' to 6.0'

Installed 6" steel casing protective collar w/ lockable cover

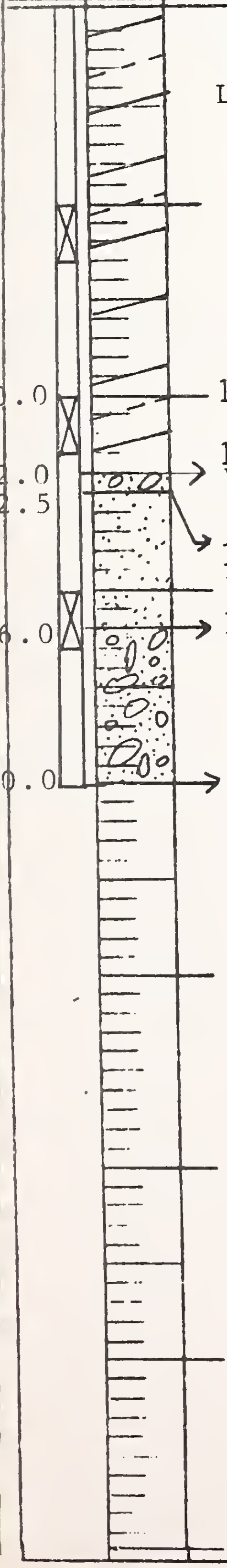
Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-140-80 Proj. No. MF 6799 (7) Hole No. 12 Date Taken 12/17/80
Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring
Location N. End T-6J City Driller Gorr, Fuller, Brigman

Collar Elev. 2906.06
Depth of Hole 20.0'
Elev. of Ground Water 2896.98
Wt. of Hammer 140 lb
Average Fall of Hammer 30"

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration



Light brown silty clay

10.0

12.0
Very loose brown sandy gravel

12.5
Medium dense grey sand

16.0

Brown sandy gravel

T.D. 20.0

Bottom of hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
-/-/-	1.5	5.0	6.5	Split Spoon
/ /				No recovery
1/2/2	1.5	10.0	11.5	
12/14/16		15.0	16.5	
/ /				
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/ /				
/ /				
/ /				

20.4' Augers 8"

21.5' 4" PVC casing perforated @ 4" intervals from 21.5' to 9.0' installed 6" steel casing protective collar w/ lockable cover

Hole No. 12a - Drilled at above location No log recorded Depth 16.1' 1" pipe

Hole No. 12b Drilled at above location No log recorded Depth 12.3' 1" pipe

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

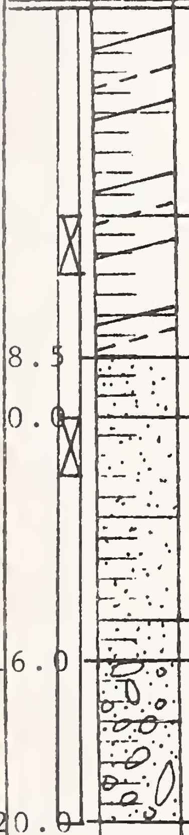
Core Log No. 6-141-80 Proj. No. MF 6799 (7) Hole No. 13 Date Taken 12/17/80

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location South End T-6J, on Dike Driller Gorr, Fuller, Brigman

Collar Elev. 2904.75
Depth of Hole 20.0'
Elev. of Ground Water 2897.51
Wt. of Hammer 140 lb
Average Fall of Hammer 30"

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Very loose light brown silty clay
8.5		8.5
10.0		10.0 Very loose brown sand
16.0		16.0 Brown sandy gravel
20.0		T.D. 20.0 Bottom of hole in same material



Blow Counts / Pene-tration

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
2/ 2/ 2	1.5	5.0	6.5	Split Spoon
2/ 3/ 2	"	10.0	11.5	" "

25.0' Augers 8"

20.0' 4" PVC casing perforated @ 4" intervals from 20.0' to 7.0' installed 6" steel casing protective collar w/ lockable cover

Hole No. 13a - Drilled at same location 10' Bx casing. 10.1" PVC pipe not perforated. Backfilled with 1.0' gravel, remainder of hole backfilled with concrete. Lockable steel collar installed.

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

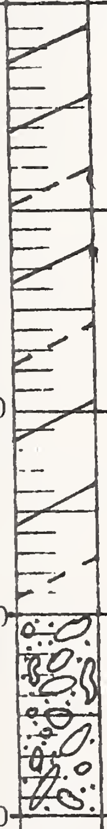
Core Log No. 6-30-81 Proj. No. MF 6799 (7) Hole No. 13b Date Taken 4/7/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location South End T-6J, on Dike Driller Gorr, Fuller, Brigman

Collar Elev. 2905.22
Depth of Hole 20.0
Elev. of Ground Water 2896.44
Wt. of Hammer -
Average Fall of Hammer -

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene- tration
		Tan silty clay		
10.0		10.0		
		15.0		
15.0		Brown sandy gravel		
20.0		T.D. 20.0 Same material		



2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
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/ /				
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/ /				

20.5' Augers 8"

20.0' 4" PVC pipe slotted at 6" intervals from 20.0' to 8.5'

No samples taken

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-1-81 **Proj. No.** MF 6799 (7) **Hole No.** 14 **Date Taken** 1/7/81

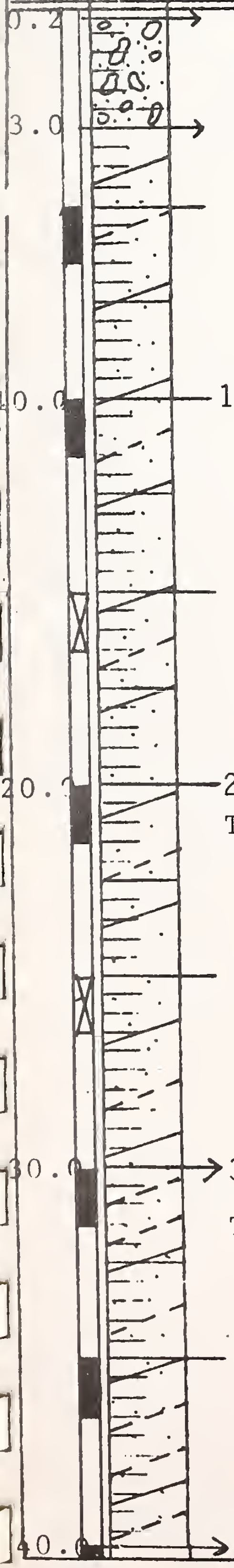
Proj. Name Kalispell Storm Drain System **Exploration Drilling for** Water Monitoring

Location East of Intersection of Woodland & 9th St. E. **Driller** Gorr & Brigman

Collar Elev.	2948.12
Depth of Hole	60.0
Elev. of Ground Water	2838.07
Wt. of Hammer	140#
Average Fall of Hammer	30"

Depth | **Legend** | **Description of Materials In Order**
1--Consistency
2--Color
3--Grade size distribution

Blow Counts | **Pene-tration**



Asphalt 0.2

Gravel (road base)

3.0

10.0

20.0
Tan sandy silty clay

30.0
Tan sandy clayey silt

40.0

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
/ /	"	15.0	16.5	"
/ /	"	20.0	21.5	"
/ /	"	25.0	26.5	"
/ /	"	30.0	31.5	"
/ /	"	35.0	36.5	"
/ /	"	40.0	41.5	"
32/50/R	0.9	45.0	45.9	Split Spoon
50/R /	0.4	50.0	50.4	" "
/ /				
/ /				
/ /				
/ /				
/ /				
/ /				

60.0' Augers 8"

25.0' 4" PVC casing perforated @ 2" intervals from 25' to 10' installed 8" steel casing protective collar w/ lockable cover

Placed 15 gal. of Bentonite mud @ 25± to 35± around both pipes

Hole No.14a - installed in same hole
depth 39.4' 1" pipe
perforated @ 2" intervals
from 39.4' to 35.0'

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

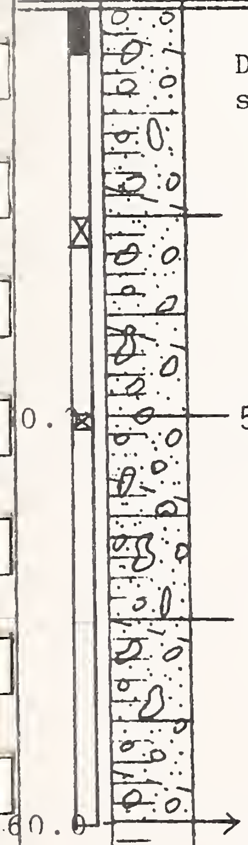
Core Log No. 6-1-81 Proj. No. MF 6799 (7) Hole No. 14 Date Taken 1/7/81

Proj. Name ______ Exploration Drilling for ______

Location ______ Driller ______

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration

Collar Elev. ______
Depth of Hole ______
Elev. of Ground Water ______
Wt. of Hammer ______
Average Fall of Hammer ______



Dense to very dense silty sandy gravel

T.D. 60.0
Bottom of hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
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Lab. Form 30
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STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

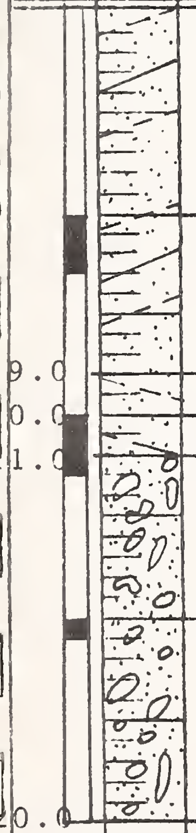
Core Log No. 6-2-81 Proj. No. MF 6799 (7) Hole No. 15 Date Taken 1/9/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Lot 2EA F. Pauli Driller Gorr & Brigman

Collar Elev. 2904.48
Depth of Hole 20.0'
Elev. of Ground Water 2896.76
Wt. of Hammer -
Average Fall of Hammer -

Depth | Legend | Description of Materials In Order
1--Consistency
2--Color
3--Grade size distribution



Light tan clayey silty sand

→ 9.0
Brown silty sand
→10.0

Grey sandy gravel

→T.D.20.0
Bottom of hole in same material

Blow Counts | Pene-tration

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
/ /	"	15.0	16.5	"
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20.0' Augers 8"

20.0' 2½" PVC casing perforated @ 4" intervals from 20.0' to 7.5' installed 6" steel casing protective collar w/ lockable cover

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

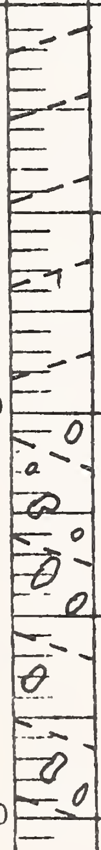
Core Log No. 6-32-81 Proj. No. MF 6799 (7) Hole No. 15a Date Taken 4/8/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Lot 2 Ea F. Pauli Driller Gorr, Fuller, Brgiman

Collar Elev. 2908.61
Depth of Hole 20.00
Elev. of Ground Water 2896.76
Wt. of Hammer -
Average Fall of Hammer -

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Brown silt
10.0		→ 10.0
		Brown gravelly silt
20.0		→ 20.0 T.D.



2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
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20.5' Augers 8"

17' 4" PVC pipe slotted at 6" intervals from 17.0' to 11.5'

No samples taken

STATE [illegible] CONSERVATION BOARD

File No.

MAY 16 [illegible] GW 2

PROJECT
HOLE #16

T. [illegible] R. [illegible]

County [illegible]

STATE OF MONTANA
ADMINISTRATOR OF GROUNDWATER CODE
OFFICE OF STATE ENGINEER

Notice of Completion of Groundwater Appropriation by Means of Well

(Under Chapter 237, Montana Session Laws, 1961)

Top of Ground
(Elev. above sea level [illegible])

2 ft top soil

fine sand

20 ft

Course sand

Water

Owner [illegible] Address [illegible]

Driller [illegible] Address [illegible]

Date of Notice of Appropriation of Groundwater.........

Date well started Oct 15/65 Date Completed Oct 15/65

Type of well Drilled
(dug, driven, bored or drilled)

Equipment Used [illegible]
(Churn, drill, rotary or other)

Water Use: Domestic ☐ Industrial ☐ Municipal ☐ Drainage ☐ Other ☐ Stock ☑ Irrigation ☐

Indicate on the diagram the character and thickness of the different strata met with in drilling, such as soil, clay, shale, gravel, rock or sand, etc. Show depth at which water is encountered, thickness and character of water-bearing strata and height to which water rises in the well.

Size of Drilled Hole	Size and Weight of Casing	From (Feet)	To (Feet)	PERFORATIONS		
				Slot Size	From (Feet)	To (Feet)
7" [illegible]	23 [illegible]		24'			

Static Water Level for non-flowing Well 17 feet.

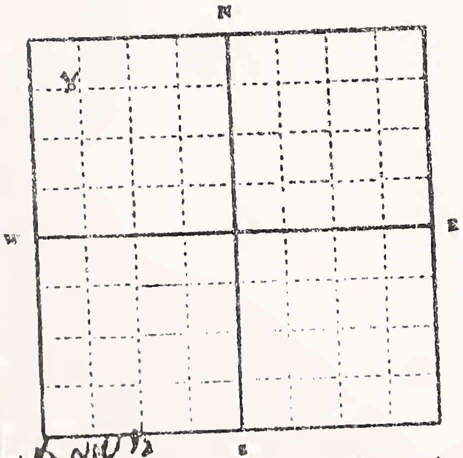
Shut-in Pressure for Flowing Well.........

Pumping Water Level 17 feet at 10 gal. per minute.

Discharge in gal. per min. of flowing well.........

How Tested Bailer Length of Test [illegible]

Remarks: (Gravel packing, cementing, packers, type of shutoff, location of place of use of groundwater if not at well, and any other similar pertinent information, including number of acres irrigated, if used for irrigation).........



N½ NW½
NW ¼ Sec. 16 T 28 R 31

Indicate location of well and place of use, if possible. Each small square represents 10 acres.

24 ft
Show exact depth of bottom.

Driller's License Number

Driller's Signature

This form to be prepared by driller, and three copies to be filed by the owner with the County Clerk and Recorder in the county in which the well is located

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

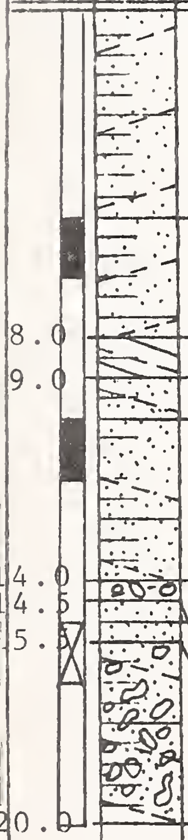
Core Log No. 1-5-81 Proj. No. MF 6799 (7) Hole No. 20 Date Taken 1/28/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location Along north edge Tract 1C Days Acres Along Days Acres LN. Extension Driller Gorr, Fuller, Brigman

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration

Collar Elev.	2903.31
Depth of Hole	20.0'
Elev. of Ground Water	2894.68
Wt. of Hammer	140#
Average Fall of Hammer	30"



Brown clayey sandy silt

8.0
Brown silty clay
9.0

Brown silty sand

14.0
Brown silty gravel
14.5
Brown sand
15.5

Brown sandy silty gravel

T.D. 20.0
Bottomed hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
32/28/23		15.0	16.5	Split Spoon
/ /				
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/ /				

20.5' Augers 8"

18.5' 4" PVC pipe perforated @ 3" intervals from 18.5' to 8.5'

Pumping rate 4 gpm

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

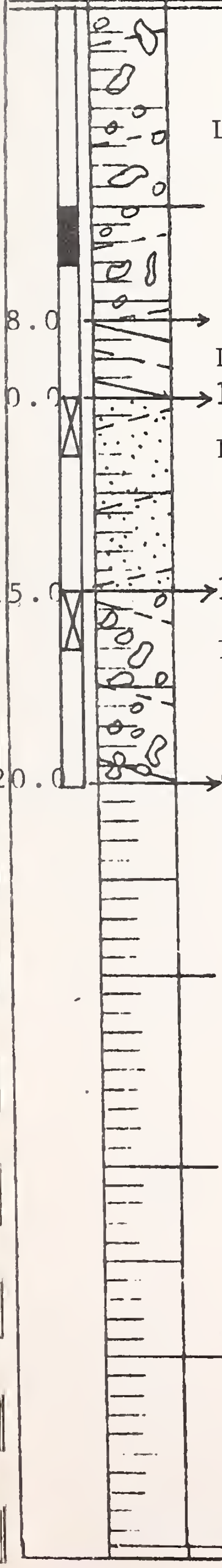
Core Log No. 1-6-81 Proj. No. MF 6799 (7) Hole No. 21 Date Taken 1/29/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location W. edge Caroline Rd. near S.E. Corner Tr. 23 Zimwald Tracts Driller Gorr, Fuller, Brigman

Collar Elev. 2902.46'
Depth of Hole 20.0'
Elev. of Ground Water 2894.89'
Wt. of Hammer 140#
Average Fall of Hammer 30"

Depth | Legend | Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution | Blow Counts | Pene-tration



Light brown silty gravel

→ 8.0
Light brown silty clay

→ 10.0
Light brown sandy silt

→ 15.0
Light brown silty gravel

→ T.D. 20.0
Bottom hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
7/19/18		15.0	16.5	Split Spoon
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/ /				
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/ /				

20.5' Augers 8"

20.0' 4" PVC pipe perforated @ 3" intervals from 20.0' to 7.5'

Pumping rate 4 gpm

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

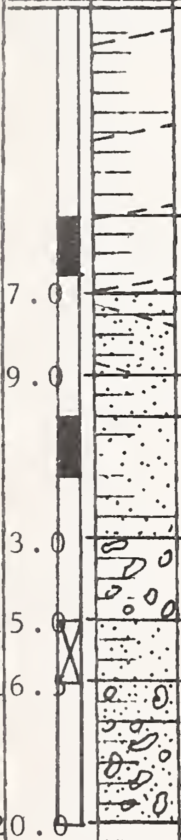
Core Log No. 1-7-81 Proj. No. MF 6799(7) Hole No. 22 Date Taken 1/29/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location W. edge Caroline Rd. near S.E. CORNER TR 31 Zimwald Tracts Driller Gore, Fuller, Brigman

Collar Elev.	2906.37
Depth of Hole	20.0
Elev. of Ground Water	2895.40
Wt. of Hammer	140#
Average Fall of Hammer	30"

Depth | Legend | Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution | Blow Counts | Pene-tration



Light brown clayey sandy silt

7.0
Light brown silty sand

9.0

Brown clayey silty sand

13.0
Gravel

15.0
Brown sand

16.0
Brown sandy gravel

T.D. 20.0

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
/ /	1.5	5.0	6.5	Shelby
/ /	"	10.0	11.5	"
34/40/29		15.0	16.5	Split Spoon
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/ /				

20.5' Augers 8"

18.0' 4" PVC pipe perforated @ 3' intervals from 18.0' to 11.0'

Pumping Rate 10 gpm

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

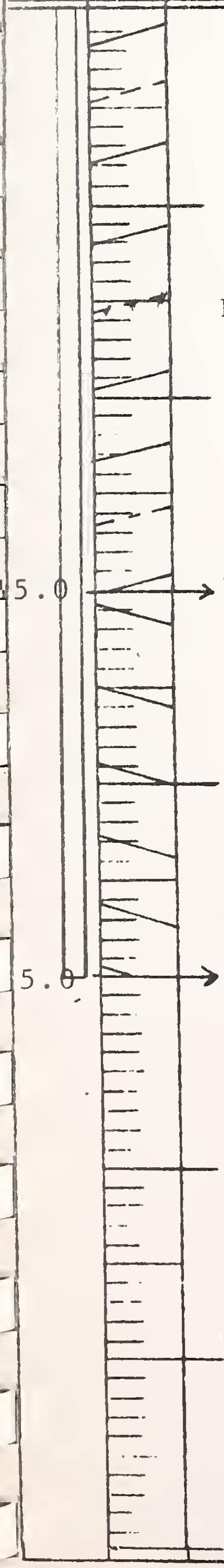
Core Log No. 6-31-81 Proj. No. MF 6799(7) Hole No. 23 Date Taken 4/7/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location S.W. Corner of Ball Park South of Blk 253, City Driller Gorr, Cloud

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene- tration

Collar Elev. 2948.85
Depth of Hole 25.0'
Elev. of Ground Water 2940.36
Wt. of Hammer -
Average Fall of Hammer -



Brown silty clay

15.0 → 15.0

Brown clay

5.0 → 25.0

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
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25.5' Augers 8"

23.0' 4" PVC pipe slotted at 6" intervals from 23.0' to 9.0'

Lab. Form 30
Revised 09-22-78

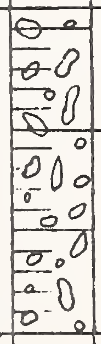
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-33-81 Proj. No. MF 6799 (7) Hole No. 24 Date Taken 4/8/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Storm Drain H_2O elevation

Location N. edge Concord Lane @ Int. with Days Acres Lane Driller Gore, Cloud

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		?
7.0		→ 7.0
		Gravel
15.0		→ 15.0



Blow Counts	Pene-tration		
		Collar Elev.	2907.74
		Depth of Hole	15.0
		Elev. of Ground Water	2895.03
		Wt. of Hammer	-
		Average Fall of Hammer	-

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
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15.5' Augers 8"

14.9' 1½" PVC pipe perforated at 6" intervals from 14.9' to 10.0'

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. ______ Proj. No. MF 6799 (7) Hole No. 25 Date Taken 9/24/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location W. edge Lot 15, Blk 1 Day's Acres Driller Swanson

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration
15.0	→	,T.D. 15.0		

Collar Elev. 2901.07
Depth of Hole 15.
Elev. of Ground Water -
Wt. of Hammer -
Average Fall of Hammer -

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
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No log

Ground water observation hole only

15' 2" PVC slotted @ 6" intervals from 15' to 5.0' at 6" intervals

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. ____ **Proj. No.** MF 6799 (7) **Hole No.** 26 **Date Taken** 9/24/81

Proj. Name Kalispell Storm Drain System **Exploration Drilling for** Water Monitoring

Location N.W. Corner Lot 11 Blk. 1 Day's Acres **Driller** Swanson

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration
15.0	→	T.D. 15.0		

Collar Elev. 2902.48
Depth of Hole 15.0
Elev. of Ground Water -
Wt. of Hammer -
Average Fall of Hammer -

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
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No log
Water observation holes only

15.0' 2" PVC slotted from 15.0' to 5.0' at 6" intervals

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. ____ Proj. No. MF 6799 (7) Hole No. 27 Date Taken 9/24/81

Proj. Name Kalispell Storm Drain System Exploration Drilling for Water Monitoring

Location N. edge Concord Lane across from N.E. Corner Lot 13 Block 2 Day's Acres Driller Swanson

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration
15.0	→	T.D. 15.0		

Collar Elev. 2905.71
Depth of Hole 15.0
Elev. of Ground Water -
Wt. of Hammer -
Average Fall of Hammer -

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
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No log

Water observation hole only

15' 2" PVC slotted at 6" intervals from 15.0' to 5.0'

Lab. Form 30
Revised 1-6-72

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-5-82 Proj. No. MF-6799-09 Hole No. 29 Date Taken Feb. 23, 1982

Proj. Name Kalispell Storm Drains Exploration Drilling for Water Monitoring

Location Gary Collier, Willow Glen Drive - Barn Driller Gorr

Collar Elev. 2905.3
Depth of Hole 20.0'
Elev. of Ground Water 4.[illegible] in hole from bottom
Wt. of Hammer
Average Fall of Hammer

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene-tration
1.5		Dark brown fine silty clay 1.5		
5.5		Brown silt 5.5		
7.0		Light brown silty sand 7.0		
		Brown silty sand and gravel " Hit gravel at 7.0' "		
20.0		20.0 Bottomed hole in same material		

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
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No samples taken

19.5' of 4" plastic pipe, 15.0' perforated, perforations 2-1/2" apart. Perf with hacksaw.

Pipe gravel packed

Drilled with 8" Augers

File 81-50

Lab. Form 30
Revised 1-6-72

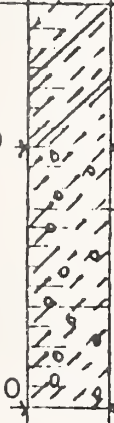
STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-6-82 Proj. No. MF 6799-09 Hole No. 30 Date Taken Feb. 23, 1982

Proj. Name Kalispell Storm Drain Exploration Drilling for Water Monitoring

Location Gary Collier, Willow Glen Drive - on property along road Driller Gorr

Collar Elev. 2909.6
Depth of Hole 20.0'
Elev. of Ground Water Dry
Wt. of Hammer
Average Fall of Hammer

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution	Blow Counts	Pene- tration
		Light brown silt with moist clay balls		
7.0		7.0		
		Brown silt and gravel		
20.0		20.0		
		Bottomed hole in same material		

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks

No samples taken

18.0' of 4" plastic pipe, 15.0' perforated, perforations 2-1/2" apart. Perf. with hacksaw.

pipe gravel packed

Drilled with 8" Augers

Lab. Form 30
Revised 1-6-72

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 6-7-82 Proj. No. MF 6799-09 Hole No. 31 Date Taken Feb. 23, 1982

Proj. Name Kalispell Storm Drains Exploration Drilling for Water Monitoring

Location Conrad Drive Driller Gorr

Collar Elev. 2908.5
Depth of Hole 20.0'
Elev. of Ground Water 1.0' water in hole from bottom
Wt. of Hammer
Average Fall of Hammer

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
		Light brown silty sand
5.0		5.0
		Fine brown sand
16.0		16.0
		Brown sandy gravel
20.0		20.0
		Bottomed hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
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No samples taken

20.0' of 4" plastic pipe, 15.0' perforated, perforations 2-1/2" apart. Perf with hacksaw

Pipe gravel packed

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 3-76-83 Proj. No. MF 6799 (9) Hole No. 34 Date Taken 5-4-83

Proj. Name Kalispell Storm Drains Exploration Drilling for Observation Wells

Location Woodland Park Area Driller Svendsen

Collar Elev. 2904.6
Depth of Hole 21.5'
Elev. of Ground Water 7.7'
Wt. of Hammer 140#
Average Fall of Hammer 30"

Depth	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
	Brown gravelly, sandy, silt
3.0	← 3.0
	Black organic silt
4.5	← 4.5
	Tan clayey silt
8.5	← 8.5
	Fine brown sand
11.0	← 11.0
	Grey organic silt
13.5	← 13.5
	Loose fine brown silty sand
15.3	← 15.3
	Loose grey gravelly sandy, clayey silt
18.0	← 18.0
	Med. dense brown gravelly silt
21.5	← 21.5
	Bottomed hole in same material

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene.	From Ft.	To Ft.	Remarks
2 / 4 / 6	1.5	15.0	16.5	Moisture sample
6 / 9 / 11	1.5	20.0	21.5	Moisture sample

2½" shelby tubes

5.0 - 7.0
10.0 - 12.0

20.5' of 8" Augers part of
1 box of samples

Installed 20.0' of 4" plastic
pipe 15' perforated 5" solid
4'x6" steel protective cap.

Hole caved @ 15'. 6' of silt
and sand in 4" pipe gravel
packed up to 1.0' grout seal
down to 1.0'

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 3-77-83 Proj. No. MF 6799 (9) Hole No. 35 Date Taken 5/4/83

Proj. Name Kalispell Storm Drains Exploration Drilling for Observation Wells

Location Woodland Park Area Driller Svendsen

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
2.0		Brown gravelly, sandy, silt 2.0 Soft brown sandy, silt
13.0		13.0 Very loose fine brown, sand
17.0		17.0 Med. dense brown gravelly, silt
21.5		21.5 Bottomed hole in same material

Blow Counts	Pene-tration	
		Collar Elev. 2905.0
		Depth of Hole 21.5'
		Elev. of Ground Water 7.7
		Wt. of Hammer 140#
		Average Fall of Hammer 30"

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
1/ 2/2	1.5	5.0	6.5	moisture sample
1/ /	1.5	10.0	11.5	moisture sample
3/ 2/2	1.5	15.0	16.5	no recovery
4/ 4/8	1.5	20.0	21.5	moisture sample
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20.5' of 8" Augers
Part of 1 box of samples

Installed 10' of 4" plastic pipe.
15' perforated, 5' solid

4'x6" steel protective cap

gravel packed up to 1.0"
grout seal down to 1.0'

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 3-78-83 Proj. No. MF 6799 (9) Hole No. 36 Date Taken 5/4/83

Proj. Name Kalispell Storm Drains Exploration Drilling for Observation Wells

Location Woodland Park Area Driller Svendsen

Depth	Legend	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
0.5		Grey clayey, silt, w/scattered gravel Brown sandy silt
9.0		9.0 Fine brown sand
11.0		11.0 Brown sandy silt
14.0		14.0 Stiff brown gravelly silt
17.5		17.5 Very dense sandy, silty gravel
21.5		21.5 Bottomed hole in same material

Blow Counts

Pene-tration

Collar Elev. 2909.0
Depth of Hole 21.5'
Elev. of Ground Water 6.0'
Wt. of Hammer 140#
Average Fall of Hammer 30"

2" Split Spoon Penetration Test - 140# Hammer

Blows	Pene	From Ft.	To Ft.	Remarks
3/3/9	1.5	15.0	16.5	moisture sample
22/32/50	1.3	20.0	21.3	moisture sample

2 1/2" shelby tubes
5.0 - 7.0
10.0 - 12.-

20.5' of 8" Augers
part of 1 box of sample

installed 20' of 4" plastic pipe
15' perforated 5' solid

4'x6" steel protective cap
gravel packed up to 1.0'
grout seal down to 1.0'

5' of silt & sand in 4" pipe

Lab. Form 30
Revised 09-22-78

STATE OF MONTANA - DEPARTMENT OF HIGHWAYS
Helena, Montana

Core Log No. 3-79-83 Proj. No. MF 6799 (9) Hole No. 37 Date Taken 5/4/83

Proj. Name Kalispell Storm Drain Exploration Drilling for Observation Wells

Location Woodland Park Area Driller Svendsen

Collar Elev. 2920.1
Depth of Hole 21.5
Elev. of Ground Water
Wt. of Hammer 140#
Average Fall of Hammer 30"

Depth	Description of Materials In Order 1--Consistency 2--Color 3--Grade size distribution
1.0	Grey clayey, silt 1.0
	Brown sandy, clayey, silt
10.5	10.5
12.0	Grey sandy, clayey, silt 12.0
	Loose brown silty clay w/ scattered gravel
17.0	17.0
	Soft brown silty clay
21.5	21.5 Bottomed hole in same material

2" Split Spoon Penetration Test - 140# Hammer

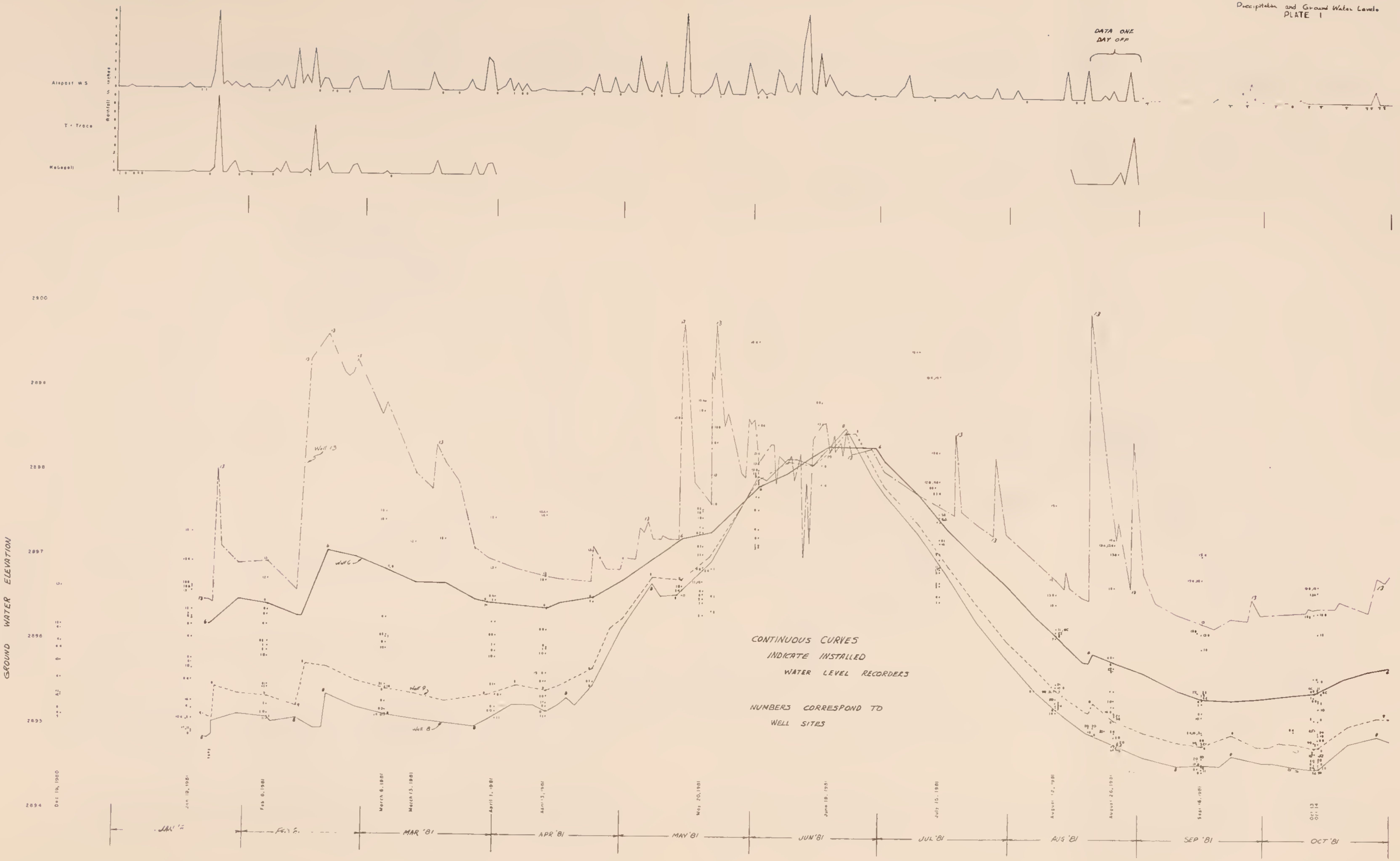
Blows	Pene.	From Ft.	To Ft.	Remarks
2 / 2 / 3	1.5	15.0	16.5	moisture sample
2 / /	1.5	20.0	21.5	moisture sample

2 1/2" shelby tube @
5.0 - 7.0
10.0 - 12.0

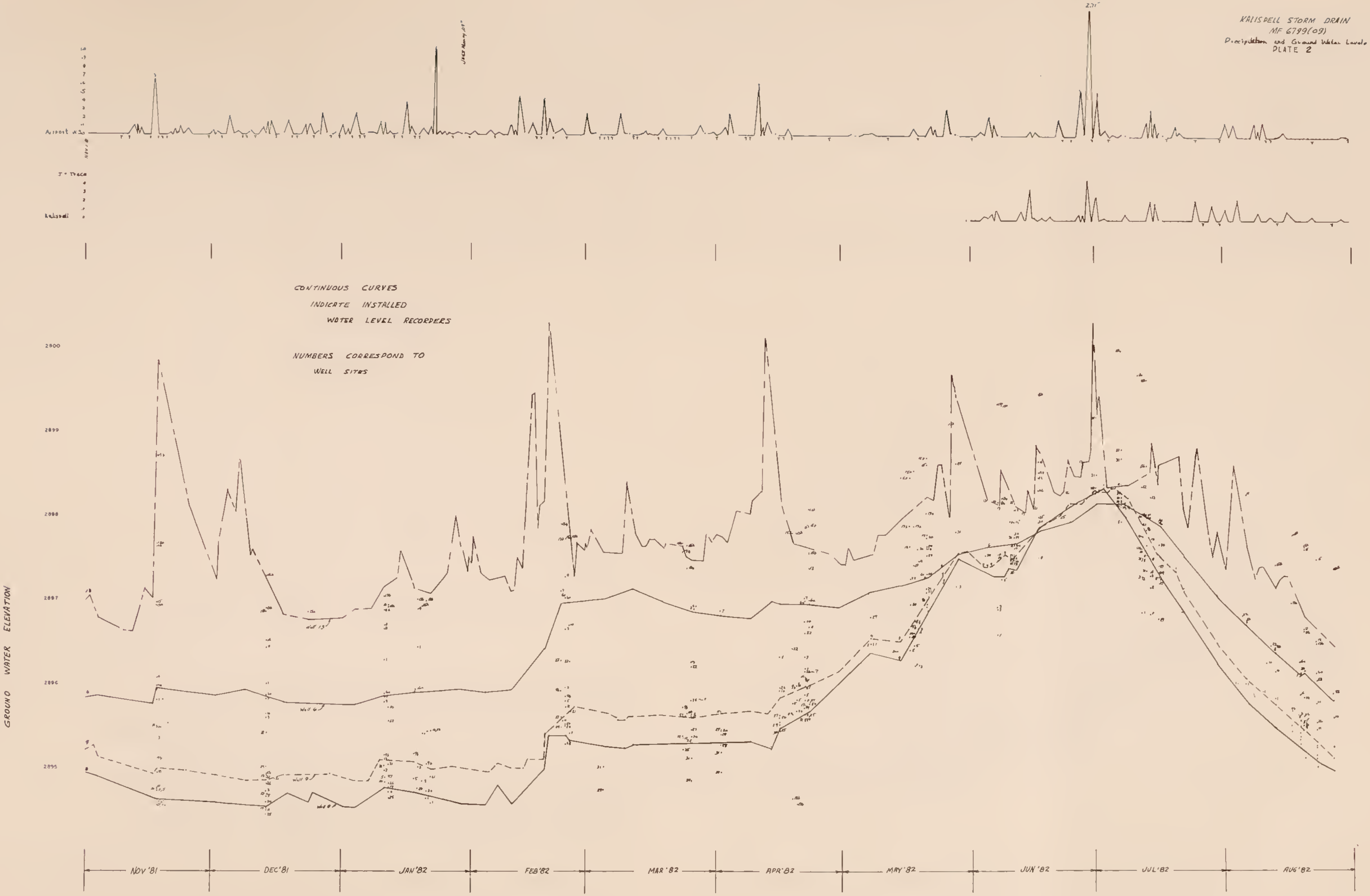
20.5' of 8" Augers
Total of 2 boxes of samples for holes 34, 35, 36 and 37

Installed 20' of 4" plastic pipe
15' perforated 5' solid
gravel packed up to 1.0'
grout seal down to 1.0'
4'x6" steel protective cap

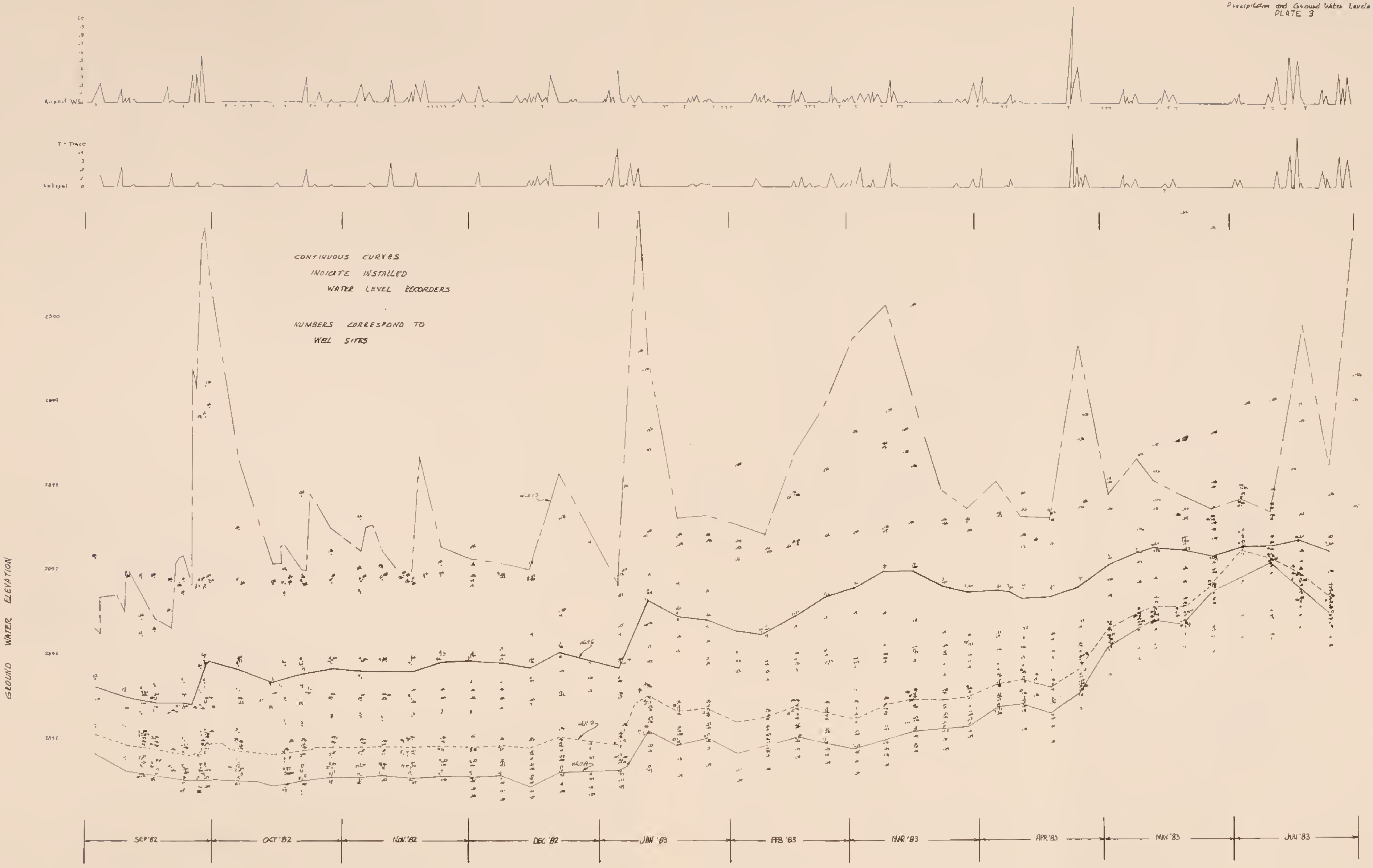
KALISPELL STORM DRAIN
MF 6799(09)
Precipitation and Ground Water Levels
PLATE 1



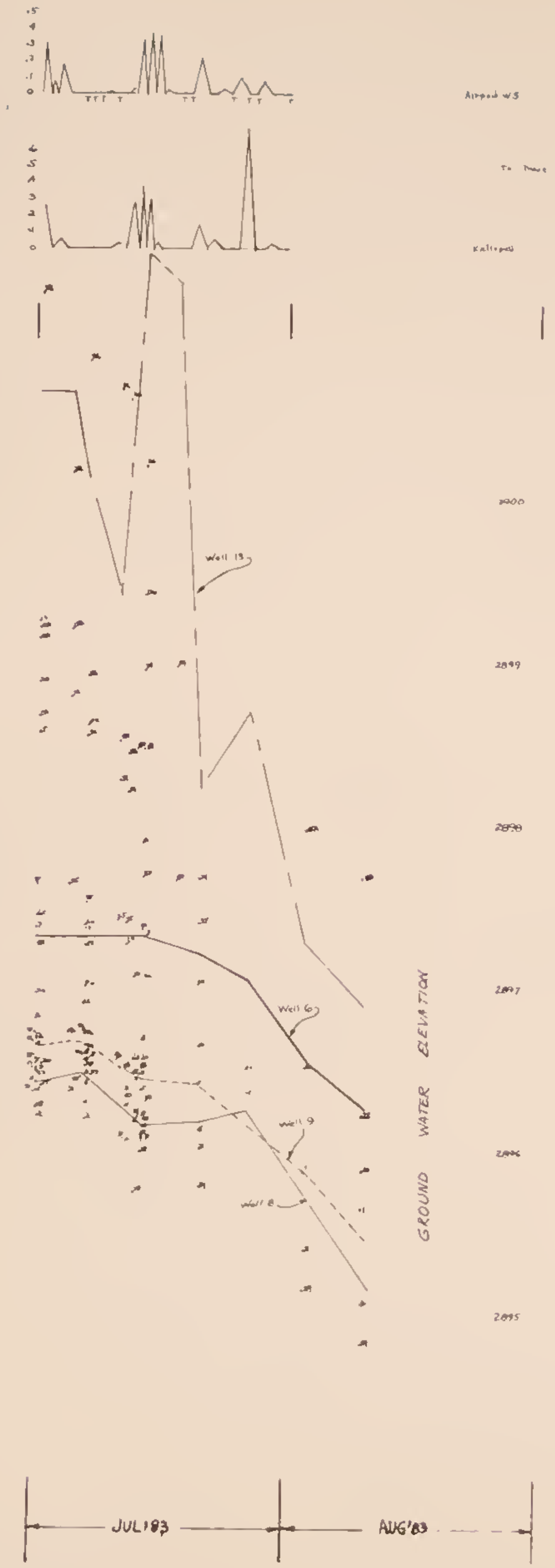
KALISPELL STORM DRAIN
MF 6799(09)
Precipitation and Ground Water Levels
PLATE 2



KALISPELL STORM DRAIN
MF 6799(09)
Precipitation and Ground Water Levels
PLATE 3

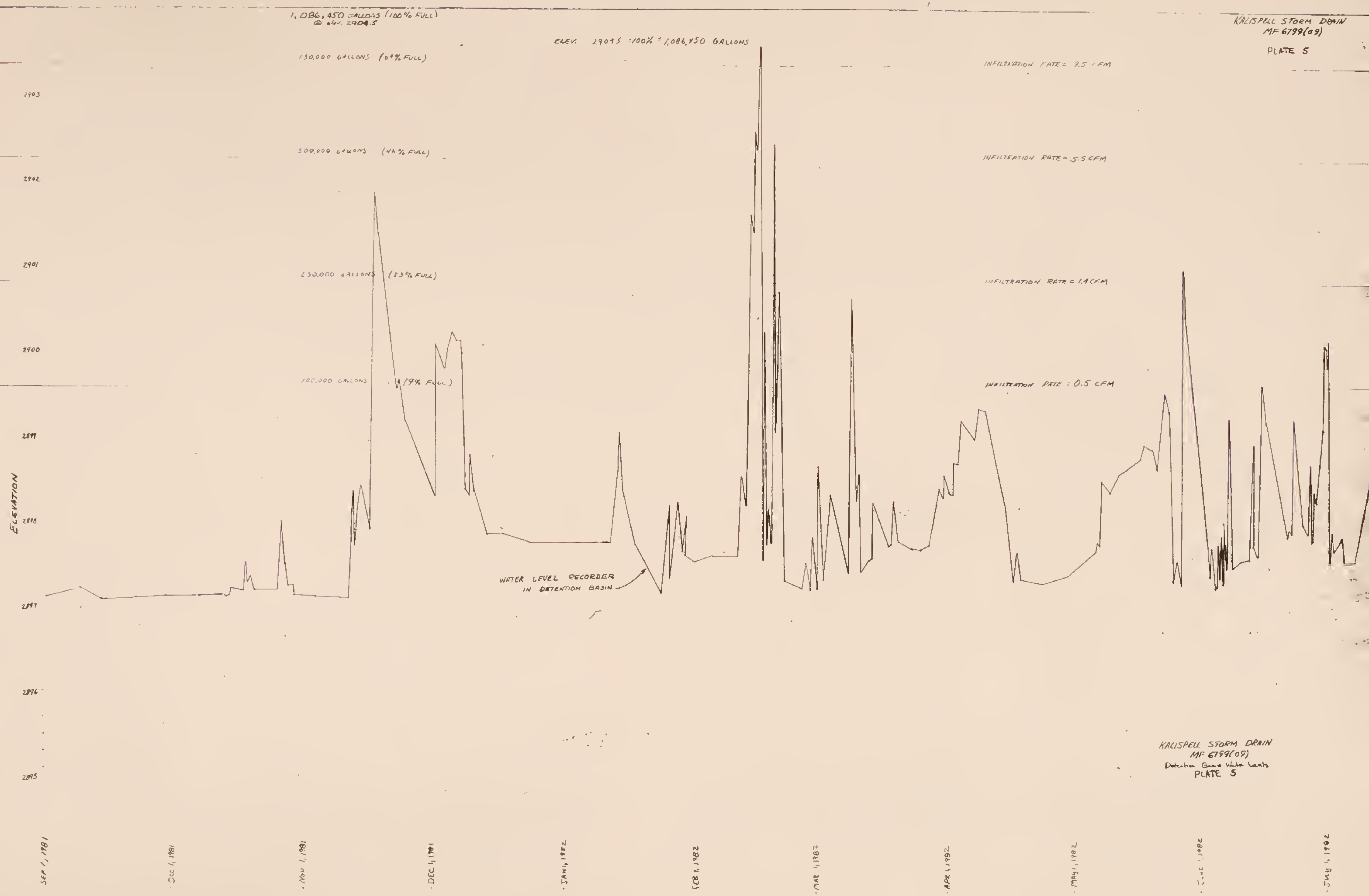


KALISPELL STORM DRAIN
MF 6799(09)
Precipitation and Ground Water Levels
PLATE 4



KALISPELL STORM DRAIN
MF 6799(09)

PLATE 5



KALISPELL STORM DRAIN
MF 6799(09)
Detention Basin Water Levels
PLATE 5